SOMAIYA VIDYAVIHAR

K J Somaiya College of Science And Commerce

Somaiya TRUST

Learning Outcome based Curriculum Framework

(LOCF)

For

M.Sc. I Geology

Postgraduate Programme

From

Academic year

2023-24

Vision & Mission

Mission:

- Equip the student with knowledge and skills of their chosen vocation,
- Inculcate values.
- Provide them opportunities for all round growth and prepare them for life.

Vision:

- To equip the students with advanced knowledge and skills in their chosen vocation.
- To provide value-based education and opportunities to students.
- To help them to face challenges in life.
- To nurture a scientific attitude, temperament and culture among the students.
- To continually review, develop and renew the approach to build India of the Founder's dream.

Goals and Objectives:

- To build a strong Academia-Industry bridge.
- To provide flexibility in the courses offered and proactively adapt to the changing needs of students and the society.
- To establish a centre for multidisciplinary activities.
- To mould individuals who would nurture the cultural heritage of our country and contribute to the betterment of the society.

SOMAIYA VIDYAVIHAR
K J Somaiya College of Science And Commerce

Somaiya TRUST

Board of Studies in Geology

Undergraduate and Postgraduate

	Name	Designation	Institute/Industry
Head of the Department			
1	Mr. Deepak Kumar Sahu	Chairman	K J Somaiya College of Science and Commerce.
Subject Expert nominated by Vice-Chancellor			
1	Dr Vikram Vishal	Associate Professor	IIT, Bombay
Subject Experts			
1	Dr. Bobby Mathew	Associate Professor	St. Xaviers College, Mumbai
2	Dr. Raymond Duraiswami	Associate Professor	Savitribai Phule Pune University
3	Dr. Pravin Henriques	Associate Professor	St. Xaviers College, Mumbai
4	Dr. Durga P Mohanty	Assistant Professor	Savitribai Phule Pune University
5	Dr. Pankaj Khanna	Assistant Professor	IIT, Gandhinagar
Representative from Industry/corporate sector/allied area			
1	Mr. Bipin Gedam	Reservoir Geologist	ONGC, Mumbai
Meritorious Alumnus			
1	Mr. Omkar Sagavekar	MSc - I	K J Somaiya College of Science and Commerce.
Faculty of the specialisation			
1	Dr. Jyoti Sharma	Assistant Professor	K J Somaiya College of Science and Commerce.
2	Dr. Anirban Mitra	Assistant Professor	K J Somaiya College of Science and Commerce.
3	Mr. Robinprince Udhaya Edward	Assistant Professor	K J Somaiya College of Science and Commerce.

Foreword

Autonomy reflects efforts for excellence in academic performances, capability of self-governance and enhancement in the quality of education. In the year 2012, the UGC and University of Mumbai conferred the Autonomous Status to K J Somaiya College of Science and Commerce. Post this recognition and having several accolades to our credit, we made significant changes to our existing syllabi to reflect the changing business, industrial and social needs. A holistic education that provides opportunities to gain and share knowledge, experiment and develop beyond curriculum, is offered at our College.

An Autonomous college carries a prestigious image for the students and the teachers and we have made a collaborative attempt to maintain a high level of quality in the standard of education that we impart.

Structured feedback obtained from the students, alumni and the experts from the industry and the changes suggested by them were duly incorporated in the syllabi. The Board of Studies constituted for each department meets to carry out in depth discussions about different aspects of the curriculum taking into cognizance the recent trends in the discipline.

The IQAC team has facilitated the conduct of a number of workshops and seminars to equip the faculty with the necessary skill set to frame the syllabi and competencies to deliver the same. Training was also provided to employ innovative evaluation methods pertaining to higher cognitive levels of revised Bloom's taxonomy. This has ensured the attainment of the learning outcomes enlisted in the syllabus. Audits are conducted to critically review the practices undertaken in teaching, learning and evaluation. Innovative learning methodologies such as project-based learning, experiential learning and flip- class learning practiced by a committed fleet of faculty and supported by several hands have been our unique outstanding propositions. All efforts have been

made to nurture the academic ambitions as well as the skills in co-curricular activities of the most important stakeholder i. e. student.

With sincere gratitude, I acknowledge the constant support and guidance extended by Shri Samir Somaiya, President- Somaiya Vidyavihar, and all the esteemed members of the Governing board and Academic council of the College. I also would like to acknowledge the Heads of the Departments and all the faculty members for their meticulous approach, commitment and significant contribution towards this endeavour for academic excellence.

Dr. Pradnya Prabhu
Principal

Acknowledgement

At the outset, I would like to thank our Principal Dr. Pradnya Prabhu for her guidance and support during the curriculum restructuring process. I am also grateful to all the esteemed members of the Board of Studies, for their constructive suggestions and contributions.

Above all, I am deeply indebted to all the young and vibrant colleagues in the Department of Geology for the long and arduous work they have put in during the compiling of the restructured syllabus.

Mr. Deepak Kumar Sahu
Chairperson
Board of Studies in Geology

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Preamble

This Learning Outcome-based Curriculum Framework (LOCF) supports the fundamental principle of providing quality education in India. We endeavour to mould young minds to participate, contribute and add value to every milestone in their path towards academic excellence. The introduction of Choice Based Credit System (CBCS) has maximized the benefits of the newly designed curriculum manifold.

The LOCF will assist teachers to envisage the outcome expected from the learners at the end of the programme. It will help them to strategize their teaching effectively. At the same time, this document will guide the students through the new curriculum and help them acquire all the skills and knowledge sets required for their personal and academic growth. Higher education qualifications such as the Master's degree Programme are awarded on the basis of demonstrated achievement of outcomes and academic standards; and this is the very essence of this curriculum.

Education is one of the most critical yardsticks in any country's development. The new National Education Policy (NEP) 2020 is an essential and comprehensive policy framework that aims to revamp the country's educational system from its foundation and to bring it at par with global standards. The larger aim of this policy is to transform the Indian education system by making it more inclusive, flexible and relevant to the changing needs of the society. Some of the key features of this policy are the introduction of vocational training, elective courses, emphasis on cultural studies, development of global skill sets and the promotion of multilingualism.

The policy seeks to bring about significant changes in the Higher Education structure, such as introducing a four-year undergraduate degree Programme, establishing multidisciplinary education and research universities, pooled credit banks and creating a National research Foundation to promote and support research

activities in various fields. The new education policy enables every student to get quality education irrespective of their socio-economic background, gender or disability. NEP 2020 enables teachers to use a variety of learning techniques and experiments.

In the current fast paced world, simply cascading the knowledge in the classroom is not sufficient especially when the global requirements keep changing. Every learner should be encouraged to exchange ideas and thoughts in a collaborative approach. This leads to developing an environment which is cognitive in nature and not a one-way information flow. Keeping all this in mind, the curriculum under Learning Outcome-based Curriculum Framework (LOCF) is designed.

1. Introduction

The M.Sc. Geology course is meticulously designed to cater to the intellectual curiosity and academic aspirations of learners delving into the intricacies of geological sciences. It offers a flexible framework that upholds the core ethos of geology programs, ensuring regular review within a comprehensive structure of agreed-upon postgraduate attributes, qualification descriptors, program learning outcomes, and course-level objectives. This program is strategically crafted to provide adaptability and innovation in curriculum development, teaching methodologies, and quality assessment, with a focus on updating pedagogy and embracing outcome-based education.

Rooted in student-centric learning principles, this curriculum aims to equip graduates with the competencies essential for careers in geological exploration, environmental consulting, and advanced research in geosciences. It underscores various graduate attributes including critical thinking, scientific reasoning, ethical awareness, and more. Notably, employability is a key consideration, ensuring that measurable teaching-learning outcomes are aligned with industry demands.

The adoption of modern pedagogical tools such as flipped classrooms, hybrid learning models, and online platforms like NPTEL and SWAYAM is encouraged within this framework. Moreover, the curriculum addresses both local and global geological issues, fostering a comprehensive understanding among students.

Each course is thoughtfully structured to provide students with substantial exposure to diverse geological topics while maintaining a balanced coverage to stimulate further exploration. Fundamental concepts spanning mineralogy, petrology, structural geology, and sedimentology are covered to establish a robust foundation

and ignite curiosity. Specialized areas such as hydrogeology and environmental geology are also incorporated to address contemporary challenges.

Practical sessions are designed to impart essential skills in fieldwork, laboratory techniques, and data analysis. Emphasis is placed on enhancing scientific writing abilities through various assignments and research projects. The program culminates with a thesis project or dissertation, enabling students to deepen their understanding and apply their knowledge to real-world geological problems.

Overall, the M.Sc. Geology course offers a dynamic and enriching academic experience, preparing students for diverse career pathways in the ever-evolving field of geological sciences.

2. Learning Outcome based Curriculum Framework

LOCF focuses on curriculum framework, curriculum aims, learning targets and objectives. The curriculum framework also provides examples of effective learning, teaching and assessment practices. As the curriculum development is a collaborative and an on-going enhancement process, the LOCF instructs periodic reviews and revisions of the curriculum in accordance with the ever-changing needs of students, teachers and society.

The framework describes how students are given exposure towards core knowledge of the subject, specialisation, choice based learning and other skill enhancement courses ensuring development of an integrated personality and employability. The template defines expected outcomes for the programme like core competency, communication skills, critical thinking, affective skills, problem-solving, analytical, reasoning, research-skills, teamwork, digital literacy, moral and ethical awareness, leadership readiness along with specific learning course outcomes at the starting of each course. The Learning Outcomes based Curriculum Framework (LOCF) for M.Sc. Geology will certainly be a valuable document in the arena of outcome-based curriculum design.

2.1 Nature and extent of M.Sc. Geology

The M.Sc. Geology program spans two years, divided into two semesters annually. It offers a comprehensive blend of traditional core subjects like mineralogy and petrology with contemporary fields such as hydrogeology and geochemistry, ensuring a well-rounded education. Specialized topics, including environmental geology and GIS, cater to diverse career interests.

To enhance employability, entrepreneurial skills specific to geology are integrated into the curriculum. Instruction emphasizes formal lectures supplemented by multimedia tools and interactive techniques like RBPT. ICT-based teaching methods

add dynamism, ensuring relevance and engagement. The goal is to cultivate versatile geoscientists ready to tackle modern challenges.

2.2 Programme Education Objectives (PEOs)

The objectives of the Master's degree program in Geology are:

1. Develop a comprehensive understanding of core concepts and skills in geology.
2. Establish a robust connection between academia and industry to enhance practical relevance.
3. Develop technical skills in specialized geological disciplines, such as hydrogeology or geomorphology, while gaining expertise in research methodologies and problem-solving approaches specific to these areas.
4. Provide opportunities for internships and research projects to refine scientific capabilities.
5. Apply acquired scientific knowledge to tackle pressing global research challenges.
6. Prepare students for further academic pursuits such as doctoral studies, national eligibility tests, or careers in Geology-related professions.
7. Foster values of global citizenship, empathy for all living beings, and commitment to sustainability.

3. Graduate Attributes in Geology

Attributes expected from graduates of the M.Sc. Geology Program include:

PGA 1: Possess a deep understanding of advanced concepts in mineralogy, structural geology, tectonics, geomorphology, petrology, sedimentary geology, hydrogeology, geophysics, and marine geology.

PGA 2: Integrate knowledge from various geological disciplines to analyze complex geological processes and phenomena, including the interactions between rocks, minerals, structures, and Earth systems.

PGA 3: Demonstrate proficiency in utilizing advanced geological techniques and tools, such as geological mapping, geochemical analysis, remote sensing, GIS (Geographic Information Systems), and geophysical surveys..

PGA 4: Develop advanced research skills, including the ability to formulate research questions, design and conduct geological investigations, collect and analyze geological data, and present research findings effectively.

PGA 5: Acquire extensive experience in conducting geological fieldwork, including the ability to identify and interpret geological features, map geological formations, and collect geological samples in diverse field settings.

PGA 6: Apply geological principles to solve complex problems effectively.

PGA 7: Communicate geological concepts clearly to diverse audiences.

PGA 8: Uphold ethical standards and professional integrity in the practice of geology, including adherence to safety protocols, environmental regulations, and ethical guidelines in geological research, exploration, and resource management.

4. Qualification descriptors

Upon successful completion of the program, students are awarded a Master's degree in Geology. M.Sc. Geology graduates of this department acquire comprehensive knowledge across various foundational and specialized branches within the field of geology, accompanied by the development of practical skills in their chosen area of specialization. Graduates are expected to demonstrate a profound understanding of geological concepts and their practical applications.

With their acquired expertise, M.Sc. Geology graduates are well-equipped to contribute to diverse sectors including research and development, academia, governmental agencies, and the public sector. This program provides a robust platform for students to further their studies in geology, whether through pursuing doctoral research or engaging in field-based investigations within the discipline.

The list below provides a synoptic overview of possible career paths provided by an undergraduate Student in Geology:

1. Academics
2. Research
3. Mining industry
4. Mineral Exploration companies
5. GIS-based companies
6. Remote sensing industry
7. Hydrogeology
8. Geohazard mitigation industry
9. Oil and Gas sector
10. Coal sector
11. Energy sector
12. Civil construction companies

13. Environmental monitoring and analysis
14. Climate change related industry

Job Roles for B.Sc. Geology graduate:

After graduation one can seek a professional career as:

1. Field Geologist
2. Laboratory Geologist
3. Geochemist
4. Geophysical surveyor
5. GIS analyst
6. Remote sensing analyst
7. Data analyst (Geological data)
8. Academist
9. Environment analyst
10. Project fellow
11. Entrepreneur
12. Civil services
13. Competitive exams

Higher Education options for B.Sc. geology graduate:

1. M.Sc./ M.Sc. Tech/ M.Tech. in Geology/ Applied Geology/ Geophysics/ Petroleum Geology/Mineral Exploration/Geo-Informatics
2. Integrated M.Sc.-Ph.D. in Geology
3. PG Diploma in advanced remote sensing and GIS,
4. Courses in management
5. B.Ed

The learners who complete two years of full-time study of an postgraduate programme of study will be awarded a Master's degree in Geology.

5. Programme Specific Outcomes (PSOs)

After the successful completion of modules in different courses of M.Sc. Geology, the learner will be able to:

PSO 1: Demonstrate an advanced understanding of key concepts and theories in various subfields of geology.

PSO 2: Possess proficient fieldwork skills, including the ability to conduct geological field studies, analyze geological formations, and interpret geological features in diverse geological settings.

PSO 3: Excel in designing, executing, and presenting geological research projects.

PSO 4: Integrate specialized knowledge from diverse areas of geology, to address complex geological problems and challenges.

PSO 5: Acquire proficiency in utilizing advanced geological techniques and tools, to investigate geological phenomena and processes.

PSO 6: Demonstrate critical thinking skills and the ability to apply geological principles and methods to analyze and solve complex geological problems

PSO 7: Develop effective written and oral communication skills, including the ability to communicate geological concepts, research findings, and interpretations to diverse audiences, including peers, professionals, and the public.

PSO 8: Uphold ethical standards and professional integrity in the practice of geology, including adherence to safety protocols, environmental regulations, and ethical guidelines in geological research, exploration, and resource management.

5.1 Course Mapping

Semester	PSO	I	II	III	IV	V	VI	VII	VIII
	Course								
I	MJ I	√		√	√	√	√	√	√
	MJ II	√	√	√	√	√	√	√	√
	MJ III	√	√		√	√	√	√	
	MJ IV	√		√	√	√	√	√	√
	DSE I	√	√	√	√	√	√	√	√
	DSE II	√	√	√	√	√	√	√	√
	DSE III	√	√	√	√	√	√	√	√
	RM			√			√	√	√
II	MJ I	√	√	√	√	√	√	√	√
	MJ II	√	√	√	√	√	√	√	√
	MJ III	√	√		√	√	√	√	√
	MJ IV	√	√	√	√	√	√	√	√
	DSE I	√	√	√	√	√	√	√	√
	DSE II	√	√	√	√	√	√	√	√
	DSE III	√	√	√	√	√	√	√	√
	OJT	√	√	√	√	√	√	√	√
III	MJ I	√	√	√	√	√	√	√	√
	MJ II	√	√	√	√	√	√	√	√
	MJ III	√	√		√	√	√	√	√
	MJ IV	√	√	√	√	√	√	√	√
	DSE I	√	√	√	√	√	√	√	√
	DSE II	√	√	√	√	√	√	√	√
	DSE III	√	√	√	√	√	√	√	√
IV	MJ I	√	√		√	√	√	√	√
	MJ II	√	√		√	√	√	√	√

	MJ III	√	√	√	√	√	√	√	√
	MJ IV	√		√	√	√	√	√	√
	RP	√	√	√	√	√	√	√	√

RM : Research Methodology Course

RP: Research Project

OJT: On Job Training.

6. Structure of M.Sc. Geology programme

The programme consists of two years (two semesters per year). The syllabus is drafted such that all significant theoretical subjects are covered in the initial three semesters with an emphasis on on-the-job training and research project/ internship/ apprenticeship work in industry or certified laboratories.

Sem	Major	DSE	RM/OJT/ RIA	Total
1	14	4	RM 4	22
2	14	4	OJT 4	22
3	16	6	-	22
4	8	-	RIA 14	22

• In semester I, the learner will have four major core courses on General Geology, one discipline specific elective and one common minor course on Research Methodology.

• In Semester II, the learner will have four major core courses on Advanced Geology, one discipline specific elective and will have to engage in an on-the-job training for 21 days.

• In Semester III the subject specialisation begins, the learner has four courses in and two discipline specific elective courses

• In Semester IV the learner has four courses in, and will have to complete one long Research Project and submit a dissertation at the end of the semester.

• Dissertation should be appreciable, original and of good quality. Assessment of dissertation will be based on an open viva for defence.

1. Major Core Courses (MJ):

a) A course which is required to be opted by a candidate as a major core course. The course designed under this category aims to cover the basics that a student is expected to imbibe in that particular subject or discipline.

b) There are sixteen Major Core courses (MJ), four each, in semesters I II, III and IV

c) Each Major Core Courses is compulsory.

d) Each Major Core Course consists of 2 credits for theory i.e. 30 hours; 2 lectures of each 1 hr per week and 1.5 credit per practical of two hours per week per course in every semester.

e) The purpose of fixing major core papers is to ensure that the institution follows a minimum common curriculum so as to adhere to common minimum standards with other universities/institutions.

2. Discipline Specific Elective (DSE) :

a) A course is chosen by the candidate from the same stream as an elective out of the three courses offered. Elective course helps the student to gain a broader understanding of the specialization in the major discipline.

b) There is one DSE course each in semester I, II and two in semester III. The credits assigned are 2 credits for theory ie. 30 hours; 2 lectures of 1 hr each per week and 2 credits for practical of four hours per week in semester 1 and 2. In semester 3, there are 2 credits for theory per course and 1 credit each for the practical.

3. Research Methodology (RM)

a) This is a mandatory Minor that all post graduate students of science have to take.

b) Students are required to achieve understanding of the various nuances of research, how to formulate a research problem, plan the work and execute it effectively. Scientific writing and other skills relevant to research are taught here.

c) This course carries 4 credits (60 - hours in class teaching)

4. On Job Training (OJT)

a) On Job training or Internships are introduced as per the guidelines of the National Education Policy (NEP) 2020, which emphasizes the importance of research and internships in undergraduate education. The internships will be mandatory for students in three-year and four-year degree programs, with a duration of 60 to 120 hours.

b) This seeks to equip students with the ability to gain relevant soft skills such as teamwork, problem-solving, work ethics, adaptability, communication, and time management.

c) This training carries 4 credits. 1 credit corresponds to 30 hours of engagement in a semester.

5. **Internship (INT):**

a) One of the fundamental principles guiding the development of our education system as per NEP 2020 is the fostering of 'outstanding research as a corequisite for outstanding education and development'. with this perspective Research project / Dissertation is a mandatory component of the masters program

b) Here the learner is assigned a research problem related to their field of specialization either within the department or at a premier institute of the country. The learner has to complete their research and present their dissertation at the end of the period.

c) Internship is introduced in semester IV of M.Sc course, having 14 credits. 1 credit of internship corresponds to 30 hours of engagement in a semester.

6.1 Course Content

Sr. No	Semester	Course number	Course Code	Course title
1	I	MJ I	23PSIGEMJIAMO	Advanced Mineralogy and Crystal Optics
2		MJ II	23PSIGEMJ2SGT	Structural Geology and Tectonics
3		MJ III	23PSIGEMJ3TGM	Tectonic Geomorphology
4		MJ IV	23PSIGEMJ4IGP	Igneous Petrology

5		MJ P	23PSIGEMJP1 23PSIGEMJP2	Practical based on each Major Course- [MJ1+MJ2=P1, MJ3+MJ4=P2]
6		DSE1	23PSIGEDSERME	Rock Mechanics and Rock Engineering
7		DSE2	23PSIGEDSEAGC	Analytical Geochemistry
8		DSE3	23PSIGEDSEVCG	Volcanology
9		DSEP	23PSIGEDSERMEP 23PSIGEDSEAGCP 23PSIGEDSEVCGP	Practical based on the DSE course
10		RM	24PSIGERM	Research Methodology
11	II	MJ I	23PS2GEMJ1SMG	Sedimentary Geology
12		MJ II	23PS2GEMJ2MMP	Metamorphic Petrology
13		MJ III	23PS2GEMJ3MEE	Mineral Exploration and Mineral Economics
14		MJ IV	23PS2GEMJ4PAL	Paleontology
15		MJ P	23PS2GEMJP1 23PS2GEMJP2	Practicals based on each major course
16		DSE I	23PS2GEDSEAPL	Applications of Paleontology
17		DSE 2	23PS2GEDSECPG	Coal and Petroleum Geology

18		DSE 3	23PS2GEDSESTI	Stratigraphy
19		DSE P	23PS2GEDSEAPLP 23PS2GEDSECPGP 23PS2GEDSESTIP	Practicals based on each DSE course
20		OJT	23PS2GEOJT	On Job Training
21	III	MJ I	24PS3GEMJIHGY	Hydrogeology
22		MJ II	24PS3GEMJIIGPY	Geophysics
23		MJ III	24PS3GEMJIIIRSG	Remote Sensing and GIS
24		MJ IV	24PS3GEMJIVMAG	Marine Geology
25		MJ P	24PS3GEMJPI 24PS3GEMJP2 24PS3GEMJP3 24PS3GEMJP4	Practicals based on each major course
26		DSE 1	24PS3GEDSEGDY	Geodynamics
27		DSE 2	24PS3GEDSEGST	Geostatistics
28		DSE 3	24PS3GEDSESGE	Soil Geology
29		DSE P	24PS3GEDSEGDYP 24PS3GEDSEGSTP 24PS3GEDSESGEP	Practicals based on any two DSE course
30	IV	MJ I	24PS4GEMJIEVG	Environmental Geology
31		MJ II	24PS4GEMJIIEAC	Earth and Climate

32		MJ III	24PS4GEMJIIINHM	Natural Hazards and Mitigation
33		MJ IV	24PS4GEMJIVITG	Instrumentation Techniques in Geology
34		RP/INT/A	24PS4GERIA	Research Project/Internship/ Apprenticeship

6.2 Credit distribution for M.Sc. Geology

Semester	Course number	Course title	Credits		
			Theory	Practical	Total
I	MJ I	Advanced Mineralogy and Crystal Optics	2	1.5	3.5
	MJ II	Structural Geology and Tectonics	2	1.5	3.5
	MJ III	Tectonic Geomorphology	2	1.5	3.5
	MJ IV	Igneous Petrology	2	1.5	3.5
	DSE	Student will choose any one DSE	2	2	4
	RM	Research Methodology	4	-	4
	Total				**22**

II	MJ I	Sedimentary Geology	2	1.5	3.5
	MJ II	Metamorphic Petrology	2	1.5	3.5
	MJ III	Mineral Exploration and Mineral Economics	2	1.5	3.5
	MJ IV	Paleontology	2	1.5	3.5
	DSE	Student will choose one DSE	2	2	4
	OJT	On Job Training	4	-	4
	Total				**22**
III	MJ I	Hydrogeology	2	2	4
	MJ II	Geophysics	2	2	4
	MJ III	Remote Sensing and GIS	2	2	4
	MJ IV	Marine Geology	2	2	4
	DSEI	Student will choose one DSE	2	1	3
	DSEII	Student will choose one DSE	2	1	3
	Total				**22**
IV	MJ I	Environmental Geology	2	-	2
	MJ II	Earth and Climate	2	-	2

	MJ III	Natural Hazards and Mitigation	2	-	2
	MJ IV	Instrumentation Techniques in Geology	2	-	2
	RIA	Research Project/ Internship/ Apprenticeship	14	-	14
	Total				**22**

6.3 Semester Schedule

Semester	Major Core Courses (MJ)	DSE [Any one per semester]	RM/ OJT/ Internship CC
I	Advanced Mineralogy and Crystal Optics	Rock Mechanics and Rock Engineering	RM -
		Analytical Geochemistry	
		Volcanology	
	Structural Geology and Tectonics		
	Tectonic Geomorphology		

	Igneous Petrology		
II	Sedimentary Geology	Applications of Paleontology	OJT
	Metamorphic Petrology	Coal and Petroleum Geology	
	Mineral Exploration and Mineral Economics	Stratigraphy	
	Paleontology		
III	Hydrogeology	Geodynamics	
	Geophysics	Geostatistics	
	Remote Sensing and GIS	Soil Geology	
	Marine Geology		
IV	Environmental Geology	-	Research Internship
	Earth and Climate		
	Natural Hazards and Mitigation		
	Instrumentation Techniques in Geology		

6.4 Course Learning Objectives

The MSc Geology program is designed to achieve several key learning objectives. Over the course of two years, students will gain a comprehensive understanding of fundamental geological concepts. Through lectures, fieldwork, and laboratory exercises, they will develop analytical and critical thinking skills necessary for solving geological problems effectively. Practical proficiency will be enhanced as students apply their knowledge to real-world scenarios. Additionally, the program aims to cultivate effective communication skills, both written and oral, enabling students to articulate geological findings convincingly. Continuous improvement will be supported through constructive feedback provided throughout the program. Moreover, students will be encouraged to consider the ethical and societal implications of geological practice, fostering a sense of responsibility within the field.

7. Detailed M.Sc. Geology Syllabus

M.Sc. Syllabus with effect from the Academic year 2023–2024

Syllabus – M.Sc I Geology

Course No.	Course Title	Course Code	Credits	Periods (1 Hr)	Module	Lectures per module (1 hr)	Examination		
							Internal Marks	External Marks	Total Marks
SEMESTER I									
Core Courses THEORY									
I	Advanced Mineralogy and Crystal Optics	23PSIGEMJIAMO	2	30	2	15	20	30	50
II	Structural Geology and Tectonics	23PSIGEMJ2SGT	2	30	2	15	20	30	50
III	Tectonic Geomorphology	23PSIGEMJ3TGM	2	30	2	15	20	30	50
IV	Igneous Petrology	23PSIGEMJ4IGP	2	30	2	15	20	30	50
Core Courses PRACTICAL									
		23PSIGEMJP1 23PSIGEMJP2	6	60			CIE		50
Discipline Specific Elective DSE [Any one]									
DSE1	Rock Mechanics and Rock Engineering	23PSIGEDSERME	2	30	2	15	20	30	50
DSE2	Analytical Geochemistry	23PSIGEDSEAGC	2	30	2	15	20	30	50
DSE3	Volcanology	23PSIGEDSEVCG	2	30	2	15	20	30	50
DSE Practical									

	Practical based on chosen DSE course	23PSIGEDSERMEP 23PSIGEDSEAGCP 23PSIGEDSEVCGP	2	30			CIE		50
Research Methodology									
RM	Fundamentals of Research and Good Laboratory Practices Research Publication and Ethics	24PSIGEGERM	4	60			CIE		100
SEMESTER II									
Core Courses THEORY									
I	Sedimentary Geology	23PS2GEMJISMG	2	30	2	15	20	30	50
II	Metamorphic Petrology	23PS2GEMJ2MMP	2	30	2	15	20	30	50
III	Mineral Exploration and Mineral Economics	23PS2GEMJ3MEE	2	30	2	15	20	30	50
IV	Paleontology	23PS2GEMJ4PAL	2	30	2	15	20	30	50
Core Courses PRACTICAL									
		23PS2GEMJP1 23PS2GEMJP2	6	60			CIE		50
Discipline Specific Elective DSE [Any one]									
DSE1	Applications of Paleontology	23PS2GEDSEAPL	2	30	2	15	20	30	50

DSE2	Coal and Petroleum Geology	23PS2GEDSECPG	2	30	2	15	20	30	50
DSE3	Stratigraphy of India	23PS2GEDSESTI	2	30	2	15	20	30	50
DSE Practical [any one]									
	Practical based on chosen DSE course	23PS2GEDSEAPLP 23PS2GEDSECPGP 23PS2GEDSESTIP	2	30			CIE		50
On Job Training									
OJT		23PS2GEOJT							

MSc GEOLOGY SEMESTER I

Major Core Course- I

COURSE TITLE: Advanced Mineralogy and Crystal Optics

COURSE CODE: 23PSIGEMJIAMO

[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to - 1. Grasp chemical elements, electronic configurations, and the Periodic Table. They'll also gain proficiency in coordinating ions using Pauling's Rule, and understand concepts like isostructuralism and polymorphism. 2. Demonstrate a comprehensive understanding of isotropic and anisotropic minerals, distinguishing their optical behaviors, interpreting optical indicatrices, analyzing interference figures, and determining optic signs in uniaxial and biaxial crystals using a petrographic microscope. 3. Demonstrate a strong comprehension of concepts of thermodynamics as applied to geological systems. They will proficiently interpret one-component and two-component phase diagrams, enabling them to analyze material behavior under various conditions. Additionally, they will apply thermodynamics to explain phase transitions and system evolution, gaining essential skills for predicting phase relationships in complex geological environments. 4. Possess a comprehensive grasp of the Earth's chemical composition and its reservoirs. They will proficiently analyze meteorite evidence, and comprehend atomic structure, isomorphism, polymorphism, and solid-solution phenomena. Additionally, they will master Goldschmidt's classification of elements, enabling them to classify and understand element

distribution in geological materials, preparing them for advanced studies and research in geology and geochemistry.

Module I	Elements of Mineral Chemistry and Crystal Optics	[15L]

Learning objectives

The module is intended to -

- Develop a comprehensive understanding of the fundamental principles and elements of mineral chemistry, including atomic structure, bonding, and the composition of minerals.
- Explain and differentiate between the optical properties of isotropic and anisotropic minerals, and demonstrate the ability to identify minerals based on their optical behavior under polarized light microscopy.

Learning outcomes

After the successful completion of the module, the learner will be able to -

- Grasp chemical elements, electronic configurations, and the Periodic Table. They'll also gain proficiency in coordinating ions using Pauling's Rule, and understand concepts like isostructuralism and polymorphism.
- Demonstrate a comprehensive understanding of isotropic and anisotropic minerals, distinguishing their optical behaviors, interpreting optical indicatrices, analyzing interference figures, and determining optic signs in uniaxial and biaxial crystals using a petrographic microscope.

Subtopic	Title	15L
1.1	Chemical elements, electronic configuration, Periodic Table, Coordination of ions: Pauling's Rule, Isostructuralism Polymorphism	8 L

1.2	Optics of Isotropic minerals and optics of Anisotropic minerals, Uniaxial and Biaxial crystals: optical Indicatrix, Interference figures, Optic sign determination	6 L

- Nesse, W. D. (2012). Introduction to Mineralogy. United Kingdom: Oxford University Press.
- Nesse, W. D. (2013). Introduction to Optical Mineralogy. United Kingdom: Oxford University Press.
- Klein, C., Dutrow, B. (2008). The 23rd edition of the manual of mineral science: (after James D. Dana). India: Wiley.

Module II	Geothermobarometry and Composition of the Earth	[15L]

Learning objectives

The module is intended to –

- Analyze and interpret phase diagrams for both one-component and two-component systems, utilizing thermodynamic principles to describe the relationships between temperature, pressure, and phase stability.
- Demonstrate proficiency in describing and analyzing phase transformations occurring in crustal and mantle rocks, including processes such as melting, crystallization, solid-state diffusion, and metamorphic reactions, and their implications for the geological evolution of Earth's crust and mantle.

Learning outcomes

After the successful completion of the module, the learner will be able to -

- Demonstrate a strong comprehension of concepts of thermodynamics as applied to geological systems. They will proficiently interpret one-component and two-component phase diagrams, enabling them to analyze material behavior under various conditions. Additionally, they will apply

thermodynamics to explain phase transitions and system evolution, gaining essential skills for predicting phase relationships in complex geological environments.

- Possess a comprehensive grasp of the Earth's chemical composition and its reservoirs. They will proficiently analyze meteorite evidence, and comprehend atomic structure, isomorphism, polymorphism, and solid-solution phenomena. Additionally, they will master Goldschmidt's classification of elements, enabling them to classify and understand element distribution in geological materials, preparing them for advanced studies and research in geology and geochemistry.

Subtopic	Title	15L
2.1	Introduction to Thermodynamics, Phase diagrams: One component diagrams and Two Component diagrams	8 L
2.2	Chemical composition of the earth and its constituent reservoirs. Meteorite evidence, Atomic structure, Isomorphism, Polymorphism and Solid-Solution. Goldschmidt's classification of elements.	7 L

- Perkins, D. (2013). Mineralogy: Pearson New International Edition. United Kingdom: Pearson Education.
- Dana, E. S. (2017). A Text-Book of Mineralogy: With an Extended Treatise on Crystallography and Physical Mineralogy (Classic Reprint). United States: FB&C Limited.
- Gribble, C. (2012). Rutley's Elements of Mineralogy. Netherlands: Springer Netherlands.
- Phillips, F. C. (1971). Introduction to Crystallography. United Kingdom: John Wiley & Sons Canada, Limited
- Kerr, P. F. (1959). Optical Mineralogy. McGraw-Hill

Question paper Template

M. Sc. (Geology) SEMESTER I

Major Core Course- I

COURSE TITLE: Advanced Mineralogy and Crystal Optics

COURSE CODE: 23PSIGEMJIAMO

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

MSc Geology Semester I

Major Core Course- II

COURSE TITLE: Structural Geology and Tectonics

COURSE CODE: 23PSIGEMJ2SGT

[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to: 1. Master the application of stress and strain concepts through 2D analysis, including various strain ellipses and Mohr diagrams. They will critically assess stress-strain compatibility and evaluate rocks' responses under stress, showcasing an advanced understanding of geological significance. 2. Understand deformation mechanisms (dislocation and diffusion creep, strain hardening, and softening) and the mechanics of rock fracturing (initiation, propagation), applying concepts such as Coluomb's criterion and Griffith's theory. 3. Possess an advanced understanding of the ductile regime, including morphological classifications of folding (fold types, mechanical aspects like buckling, bending, flexural slip, and flow folding), mechanics of single-layer and multi-layer folds, and the complexities of fold interference and superposed folds. 4. Demonstrate proficiency in analyzing structures in the brittle regime, encompassing faulting (mechanics, Anderson's theory, fault geometry types), joints (tectonic, columnar, release joints, and their relation to folds and faults), and shear zones (geometry, kinematics, strain analysis, shear sense indicators).

They will understand the importance of these structures in continental crustal evolution.

Module I	Introduction to Rock Mechanics and Rheology	[15L]

Learning objectives

The module is intended to –

- Gain expertise in ductile regime concepts, including fold classifications and complexities, and analyze fold interference.
- Develop proficiency in analyzing brittle regime structures like faults, joints, and shear zones, understanding their role in crustal evolution.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Master the application of stress and strain concepts through 2D analysis, including various strain ellipses and Mohr diagrams. They will critically assess stress-strain compatibility and evaluate rocks' responses under stress, showcasing an advanced understanding of geological significance.
- Understand deformation mechanisms (dislocation and diffusion creep, strain hardening, and softening) and the mechanics of rock fracturing (initiation, propagation), applying concepts such as Coluomb's criterion and Griffith's theory.

Subtopic	Title	15L
1.1	Concept of Stress and Strain: 2D stress and strain analysis; different types of strain ellipses and their geological significance; Mohr diagrams and their use; concept of stress-strain compatibility; Behaviour of rocks under stress: elastic, plastic, viscous and visco-elastic responses and their geological	7 L

	significance.	
1.2	Deformation mechanism in grain scale: dislocation and diffusion creep, strain hardening and softening mechanism, lattice preferred orientation. Mechanics of rock fracturing: fracture initiation and propagation; Coluomb's criterion and Griffith's theory.	8 L

References

- Bayly, B. (1991). Mechanics in Structural Geology. Germany: Springer New York.
- Reynolds, S. J., Davis, G. H. (1996). Structural geology of rocks and regions. United Kingdom: Wiley.
- Ghosh, S. K. (1993). Structural Geology: Fundamentals and Modern Developments. South Korea: Elsevier Science & Technology Books.
- Means, W. (2012). Stress and Strain: Basic Concepts of Continuum Mechanics for Geologists. United States: Springer New York.

Module II	Analysis of Geological Structures	15L

Learning objectives

The module is intended to –

- Gain expertise in ductile regime concepts, including fold classifications and complexities, and analyze fold interference.
- Develop proficiency in analyzing brittle regime structures like faults, joints, and shear zones, understanding their role in crustal evolution.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Possess an advanced understanding of the ductile regime, including morphological classifications of folding (fold types, mechanical aspects like buckling, bending, flexural slip, and flow folding), mechanics of single-layer and multi-layer folds, and the complexities of fold interference and superposed folds.
- Demonstrate proficiency in analyzing structures in the brittle regime, encompassing faulting (mechanics, Anderson's theory, fault geometry types), joints (tectonic, columnar, release joints, and their relation to folds and faults), and shear zones (geometry, kinematics, strain analysis, shear sense indicators). They will understand the importance of these structures in continental crustal evolution.

Subtopic	Title	15L
2.1	Fold - Morphological classification of folding. Mechanical aspects of folding: buckling, bending, flexural slip and flow folding. Mechanics of single-layer and multi-layer folds. Fold interference and superposed folds.	5 L
2.2	Foliation and Lineation - Different types of planar and linear structures in a deformed rock, Kinematic significance of foliation and lineation. Importance of cleavage-bedding intersection in a folded terrain.	2 L
2.3	Faulting - Mechanics of faulting: Anderson's theory and limitations. Geometry of strike-slip, thrust and normal faults with natural example; Fault reactivation and its significance.	3 L
2.4	Joints - Importance of tectonic, Columnar and release joints, Joints with relation to fold and faults.	2 L

2.5	Shear zones - Geometry and kinematics: Analysis of strain in shear zone, kinematic significance of different shear zone structures, shear sense indicators, Large scale shear zones and their importance in continental crustal evolution.	3 L

References

- Leyshon, P. R., Lisle, R. J. (2004). Stereographic projection techniques for geologists and civil engineers. Spain: Cambridge University Press.
- Passchier, C., Trouw, R. (2013). Microtectonics. Germany: Springer Berlin Heidelberg.
- Ramsay, J. G. (1967). Folding and fracturing of rocks. Mc Graw Hill Book Company,568.
- Bhattacharya, A. (2022). Structural Geology. Switzerland: Springer International Publishing.
- Twiss, R. J., Moores, E. M. (2007). Structural geology. United Kingdom: W. H. Freeman.

Question paper Template

MSc Geology Semester I

Major Core Course- II

COURSE TITLE: Structural Geology and Tectonics

COURSE CODE: 23PSIGEMJ2SGT

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

MSc Geology Semester I

Major Core Course- III

COURSE TITLE: Tectonic Geomorphology

COURSE CODE 23PSIGEMJ3TGM

[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to – • Demonstrate an understanding of the principles and processes of active tectonics and their role in landscape development. • Demonstrate proficiency in applying dating methods and interpreting geomorphic expressions of tectonic processes to establish temporal frameworks in landscapes. • Demonstrate proficiency in analyzing short-term deformation phenomena using near-field and far-field techniques, contributing to seismic hazard assessment and landscape evolution studies. • Critically interpret paleo-seismological data to understand rates of uplift, erosion, and denudation over Holocene and late Cenozoic timescales, informing landscape evolution and tectonic processes assessments.		
Module I	Introducing Tectonic Geomorphology	15 L
Learning objectives The module is intended to – • Identify and interpret geomorphic markers associated with active tectonic processes, including planar features such as fault scarps and linear features such as fault-controlled drainage patterns.		

- Apply dating methods to establish temporal constraints on landscape evolution influenced by active tectonics, including determining the ages of faulted and folded landforms, terraces, and other geomorphic features.

Learning outcomes

After the successful completion of the module, the learner will be able to -

- Demonstrate an understanding of the principles and processes of active tectonics and their role in landscape development.
- Demonstrate proficiency in applying dating methods and interpreting geomorphic expressions of tectonic processes to establish temporal frameworks in landscapes.

Subtopic	Title	15L
1.1	Active Tectonics and models of Landscape development; Geomorphic Markers: Planar and Linear and commonly encountered problems with markers;	8 L
1.2	Establishing Time in Landscapes: Dating methods, Earthquake Cycle, Geomorphic Expression of Faults, folds.	7 L

References

- Anderson, R. S., Burbank, D. W. (2011). Tectonic Geomorphology. Germany: Wiley.
- Kale, V. S. (2023). Processes, Products and Cycles of Tectonic Geomorphology. United States: Elsevier Science.
- Summerfield, M. A. (2014). Global Geomorphology. United Kingdom: Taylor & Francis.

Module II	Geomorphology in Timescales	15L

Learning objectives

The module is intended to –

- Analyze and differentiate between near-field and far-field techniques used in the study of short-term deformation, including their applications in monitoring seismic events and understanding strain distribution.
- Evaluate the methodologies and data interpretation techniques employed in paleo-seismology, focusing on reconstructing past seismic events, assessing recurrence intervals, and understanding landscape responses to tectonic activity over geological time scales.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Demonstrate proficiency in analyzing short-term deformation phenomena using near-field and far-field techniques, contributing to seismic hazard assessment and landscape evolution studies.
- Critically interpret paleo-seismological data to understand rates of uplift, erosion, and denudation over Holocene and late Cenozoic timescales, informing landscape evolution and tectonic processes assessments.

Subtopic	Title	15L
2.1	Near and Far field techniques in Short term deformation, Paleo-seismology, Rates of uplift, erosion and denudation, Holocene deformation and landscape response.	9 L
2.2	Deformation and Geology at intermediate time scales, Tectonic Geomorphology at late Cenozoic timescales, Numerical modelling of landscape evolution.	6 L

References

- Ollier, C. (1981). Tectonics and landforms. Hong Kong: Longman.
- Sugden, D. E., Schumm, S. A., Chorley, R. J. (2019). Geomorphology. United Kingdom: Taylor & Francis.
- Selby, M. J. (1985). Earth's changing surface: an introduction to geomorphology. United Kingdom: Clarendon Press.

Question paper Template

M. Sc. (Geology) SEMESTER I

Major Core Course- III

COURSE TITLE: Tectonic Geomorphology

COURSE CODE 23PSIGEMJ3TGM

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

MSc Geology Semester I

Major Core Course- IV

COURSE TITLE: Igneous Petrology

COURSE CODE 23PSIGEMJ4IGP

[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to - • Apply the IUGS classification system to identify and differentiate major rock types, while interpreting textures and structures in igneous rocks. • Grasp the origin, evolution, and textures of magmas, considering viscosity, temperature, pressure relationships. Apply thermodynamic principles to assess volcanic activity and predict geological history in igneous rocks. • Interpret igneous rock chemical analyses, major and trace elements, silica/alumina saturation, and variation diagrams. Gain insights into petrography and origin of various rock types. • Investigate the geologic context of mantle metasomatism, hotspot magmatism, and large igneous provinces in India, applying knowledge to real-world scenarios.		
Module I	Classification and Evolution of Magmas	15L
Learning objectives The module is intended to – • Develop the ability to apply the IUGS classification system for the identification and differentiation of major rock types, while effectively interpreting textures and structures present in igneous rocks.		

- Understand the origin, evolution, and textures of magmas, considering factors such as viscosity, temperature, and pressure relationships. Apply thermodynamic principles to evaluate volcanic activity and predict geological histories associated with igneous rocks.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Apply the IUGS classification system to identify and differentiate major rock types, while interpreting textures and structures in igneous rocks.
- Grasp the origin, evolution, and textures of magmas, considering viscosity, temperature, pressure relationships. Apply thermodynamic principles to assess volcanic activity and predict geological history in igneous rocks.

Subtopic	Title	15 L
1.1	Classification of igneous rocks. IUGS classification. Textures and structures of igneous rocks.	4 L
1.2	Origin and evolution of magmas. Viscosity, temperature and pressure relationships in magmas, nucleation and growth of minerals in magmatic rocks, development of igneous textures;	7 L
1.3	Magmatic evolution (differentiation, assimilation, mixing and mingling); Binary and Ternary Systems;	4 L

References

- Cox, K.G., Bell, J.D., Pankhurst, R.J., 1993. The Interpretation of Igneous Rocks, Chapman and Hall, London

- McBirney, A.R., 1993. Igneous Petrology, Jones & Bartlett Publishers, Boston
- Philpotts, A.R., Ague, J.J., 2009. Principles of Igneous and Metamorphic Petrology, Cambridge University Press, New York
- Best, M.G., 2003. Igneous and Metamorphic Petrology, Blackwell Publishing

Module II	Types of Igneous Rocks and Petrogenesis	15L

Learning objectives

The module is intended to –

- Develop the ability to apply the IUGS classification system for the identification and differentiation of major rock types, while effectively interpreting textures and structures present in igneous rocks.
- Understand the origin, evolution, and textures of magmas, considering factors such as viscosity, temperature, and pressure relationships. Apply thermodynamic principles to evaluate volcanic activity and predict geological histories associated with igneous rocks.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Interpret igneous rock chemical analyses, major and trace elements, silica/alumina saturation, and variation diagrams. Gain insights into petrography and origin of various rock types.
- Investigate the geologic context of mantle metasomatism, hotspot magmatism, and large igneous provinces in India, applying knowledge to real-world scenarios.

Subtopic	Title	15L
2.1	Representation of chemical analysis of igneous rocks. Major	3 L

	and Trace element systematics in igneous rocks. Silica/alumina saturation, variation diagrams, their applications and limitations.	
2.2	Ultramafic and layered rocks, Kimberlites and their origin. Lamprophyres and their petrography and origin. Granites and their origin, S-, I-, A-, M- type granites. Pegmatites, their nature, occurrence and petrogenesis..	6 L
2.3	Alkaline rocks and their origin. Anorthosites and their petrogenesis. Carbonatites, Petrography and their petrogenesis. Mantle metasomatism, hotspot magmatism and large igneous provinces of India	6 L

Reference

- Wilson, M., 2007. Igneous Petrogenesis – A Global Tectonic Approach, Springer, Dordrecht
- Gill, R., 2010. Igneous Rocks and Processes: A Practical Guide, Wiley-Blackwell, Oxford
- Winter, J.D., 2014. Principles of Igneous and Metamorphic Petrology, PHI Learning Private Limited

Question paper Template

M. Sc. (Geology) SEMESTER I

Major Core Course- IV

COURSE TITLE: Igneous Petrology

COURSE CODE 23PSIGEMJ4IGP

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

MSc Geology Semester I

Practical

23PSIGEMJP1

Core Course I	Advanced Mineralogy and Crystal Optics Practical

Learning Objectives

This practical is intended to

1. Develop proficiency in identifying rock-forming minerals through microscopic examination and hand specimen analysis.
2. Acquire skills in performing mineral formula calculations and interpreting X-ray diffraction (XRD) data.

Learning Outcomes

After completion of this practical, learner will be able to

1. Accurately identify a variety of rock-forming minerals using both microscopic and hand specimen techniques, demonstrating a comprehensive understanding of mineral characteristics and properties.
2. Demonstrate proficiency in calculating mineral formulas based on chemical composition data and interpreting XRD patterns to identify crystallographic structures, showcasing their ability to apply theoretical knowledge to practical geological analyses.

1. Microscopic identification of Rock forming minerals
2. Hand Specimen Identification of Rock forming minerals
3. Mineral Formula Calculation
4. XRD Calculations

Core course II	Structural Geology and Tectonics Practical

Learning Objectives

This practical is intended to

1. Develop proficiency in analyzing and interpreting geological maps to understand geological structures and formations.
2. Gain expertise in stereographic analysis of structural data using specialized software and traditional techniques, such as contour diagrams, for interpreting regional structural geometries.

Learning Outcomes

After completion of this practical, learner will be able to

1. Effectively analyze geological maps, identifying key geological features, structures, and formations, and interpret the geological history and processes they represent.
2. Skillfully analyze structural data digitally and traditionally, enabling accurate interpretation of complex geometries, including foliation and lineation orientation analyses for regional understanding.

1. Analyses and interpretation of geological maps
2. Stereographic analysis of structural data; Use of specialized softwares, e.g. GEOrient
3. Stereographic techniques: Significance of contour diagrams: orientation analyses of foliation and lineation data for regional structural geometry.
4. Structural problems related to borehole data.
5. Subsurface structures using Borehole data

MSc Geology Semester I

Practical

23PSIGEMJP2

Core course III	Tectonic Geomorphology Practical

Learning objectives

This Practical is intended to

1. Develop proficiency in assessing hillslope sediment transport processes and their implications for landscape evolution.
2. Gain expertise in analyzing basin morphometry, hypsometry, and fault plane geometry to understand tectonic and geomorphic processes.

Learning Outcomes

After the successful completion of the Practical, the learner will be able to

1. Analyze and interpret hillslope sediment transport mechanisms, basin morphometry, and hypsometric data to infer landscape evolution patterns and processes.
2. Demonstrate competence in evaluating active tectonics through the assessment of fault plane geometry, slope-area analysis, and paleoseismological methods, facilitating a comprehensive understanding of landscape dynamics and the control of tectonic processes on landform evolution.

1. Hillslope Sediment Transport
2. Basin Morphometry
3. Hypsometric Analysis
4. Assessment of Active Tectonics
5. Fault plain Geometry
6. Slope-Area Analysis and River Terraces

7. Paleo-Seismology and Field Neotectonics Method
8. Control of tectonics
9. Rate of Subsidence

Core course IV	Igneous Petrology Practical

Learning Objectives:

This Practical is intended to

1. Develop proficiency in identifying igneous rocks through both hand specimen examination and microscopic analysis.
2. Acquire skills in classifying igneous rocks using various classification schemes such as TAS (Total Alkali-Silica), IUGS (International Union of Geological Sciences), and CIPW (Normative Mineralogy) norms.

Learning Outcomes:

After the successful completion of the Practical, the learner will be able to

1. Accurately identify a variety of igneous rocks through hands-on examination and microscopic analysis, demonstrating a comprehensive understanding of their mineralogical and textural characteristics.
2. Demonstrate proficiency in classifying igneous rocks based on different classification schemes, including TAS, IUGS, and CIPW norms, showcasing their ability to apply theoretical knowledge to practical geological analyses.

1. Hand-specimen Identification of Igneous Rocks
2. Microscopic Identification of Igneous Rocks
3. Igneous Rock Classification based on TAS, IUGS, CIPW norm

MSc Geology Semester I

Discipline Specific Elective - I

COURSE TITLE: Rock Mechanics and Rock Engineering

COURSE CODE 23PSIGEDSERME

[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to – 1. Demonstrate a holistic understanding of rock mechanics, encompassing the analysis of stress and strain, application of constitutive relations, evaluation of parameters influencing strength and stress-strain behavior, and proficiency in employing failure criteria for both rocks and rock masses in diverse geological and engineering contexts. 2. Master classical theories of rock failure, including Coulomb's criterion, Mohr's criterion, Griffith's theory, and empirical failure criteria, enabling them to comprehensively analyze and predict the behavior of jointed rock masses in geological and engineering applications. 3. Proficiently assess the strength and deformability of rock masses through in-situ shear tests, in-situ bearing strength tests, and in-situ deformability tests (including Plate Loading Test, Plate Jacking Test, and Borehole Jack Tests), equipping them with the skills to make informed engineering decisions related to the behavior of rock masses under various loading conditions. 4. Understand intact rock's engineering properties, including physico mechanical characteristics, and gain proficiency in engineering geological investigations, rock and soil classification methods, and ground improvement techniques like grouting, forepoling, pre-reinforcement, and shotcreting.

Module I	Concept of Stress, Strain and Failure or Rocks	15L

Learning objectives

The module is intended to

1. Analyze stress and strain in rocks, apply constitutive relations, and identify factors affecting strength and stress-strain behavior.
2. Master classical theories of rock failure, including Coulomb's, Mohr's, Griffith's theories, and empirical criteria, for predicting jointed rock mass behavior.

Learning outcomes

After the successful completion of the module, the learner will be able to –

1. Demonstrate a holistic understanding of rock mechanics, encompassing the analysis of stress and strain, application of constitutive relations, evaluation of parameters influencing strength and stress-strain behavior, and proficiency in employing failure criteria for both rocks and rock masses in diverse geological and engineering contexts.
2. Master classical theories of rock failure, including Coulomb's criterion, Mohr's criterion, Griffith's theory, and empirical failure criteria, enabling them to comprehensively analyze and predict the behavior of jointed rock masses in geological and engineering applications.

Subtopic	Title	15 L
1.1	Analysis of stress, Analysis of strain, Constitutive relations, Parameters influencing strength / stress-strain behavior. Failure Criteria for Rock and Rock Mass	7 L
1.2	Classical theories of rock failure: Coulomb's criterion, Mohr's criterion, Griffith's theory, Empirical failure criteria. Behaviour	8 L

	of jointed rock mass.	

References:

- Cook, N. G. W., Jaeger, J. C. (1979). Fundamentals of rock mechanics. Netherlands: Springer Netherlands.
- Verma, A. K., Debasis, D. (2016). Fundamentals and Applications of Rock Mechanics. India: Prentice Hall India Pvt., Limited.
- Harrison, J. P., Hudson, J. A. (2000). Engineering Rock Mechanics: An Introduction to the Principles. Netherlands: Elsevier Science.

Module II	Rock Mass Testing, Engineering Properties and Ground Improvement	15L

Learning objectives

The module is intended to –

1. Develop proficiency in conducting laboratory tests to determine key mechanical properties of rocks, including modulus of elasticity, Poisson's ratio, compressive strength, tensile strength, tri-axial strength, and shear strength.
2. Acquire skills in conducting field and laboratory tests to assess soil properties, including Atterberg's limits, and applying geological engineering methods for slope stability analysis using tools like RMR (Rock Mass Rating) and RQD (Rock Quality Designation).

Learning outcomes

After the successful completion of the module, the learner will be able to –

1. Evaluate rock strength and deformability with in-situ tests like shear, bearing, and deformability tests, enabling informed engineering decisions on rock behavior under different loads.

2. Master intact rock properties, geological investigations, and ground improvement techniques such as grouting and shotcreting.		
Subtopic	**Title**	**15 L**
2.1	Strength and Deformability of Rock Mass In situ shear tests; Evaluation of shear strength; In situ bearing strength test; In situ deformability tests- Plate Loading Test, Plate Jacking Test and Borehole Jack Tests	5 L
2.2	Engineering properties of intact rock – physico-mechanical, Overview of requirements, methods and analysis of engineering-geological investigation methods, Rock mass classification methods and their applications, Soil classification methods and their applications	5 L
2.3	Ground improvement; grouting, fore polling, pre reinforcement, shotcreteing and others	5 L

References:

- Hencher, S. (2015). Practical Rock Mechanics. United Kingdom: CRC Press.
- Goodman, R. E. (1989). Introduction to rock mechanics. United Kingdom: Wiley.
- Aydan, Ö. (2020). Rock Mechanics and Rock Engineering. Netherlands: CRC Press.
- Cosgrove, J. W., Hudson, J. A. (2016). Structural Geology And Rock Engineering. Singapore: World Scientific Publishing Company.

Question Paper Template

M. Sc. (Geology) SEMESTER I

Department Specific Elective - I

COURSE TITLE: Rock Mechanics and Rock Engineering

COURSE CODE 23PSIGEDSERME

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

Practical

23PSIGEDSERMEP

DSE I	Rock Mechanics and Rock Engineering Practical

Learning Objectives

This Practical is intended to

1. Master laboratory tests for rock mechanical properties and soil analysis techniques.
2. Apply geological engineering methods for slope stability assessment and infrastructure planning.

Learning Outcomes

After the successful completion of the Practical, the learner will be able to

1. Students will accurately determine rock mechanical properties and soil characteristics.
2. They will proficiently analyze slope stability and make informed decisions for construction projects

1. Determination of modulus of elasticity, Poisson's ratio and compressive strength of rock.
2. Determination of tensile strength of rock and tri-axial strength of rock
3. Determination of shear strength of rock
4. Determination of Atterberg's limits of soil
5. Slope Stability analysis
6. RMR and RQD

MSc Geology Semester I

Discipline Specific Elective - II

COURSE TITLE: Analytical Geochemistry

COURSE CODE 23PSIGEDSEAGC

[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to – 1. Apply analytical techniques such as XRF, ICP-MS, EPMA, and SEM-EDS for sampling, analyses, and geo-standards, ensuring precision in determining mineral and glass compositions, major, minor, and trace elements, oxidation states, and volatile content. 2. Demonstrate competency in calculating mineral formulae, interpreting chemical compositions, and employing variation diagrams, enabling the classification of magmatic rocks based on whole-rock composition and chemical discriminants. 3. Proficiently understand stable and radiogenic isotopes, utilizing them as petrogenetic indicators, and interpreting chronological data, demonstrating expertise in isotope applications. 4. Gain hands-on experience with Isoplot, enabling effective interpretation and presentation of isotopic data, and reinforcing practical skills in handling chronological information.

Module I	Composition and classification of magmatic rocks	15L

Learning objectives

The module is intended to –

1. Develop proficiency in the application of analytical techniques such as XRF, ICP-MS, EPMA, and SEM-EDS for sampling, analyses, and the utilization of geo-standards, ensuring precision in determining mineral and glass compositions, as well as major, minor, and trace elements, oxidation states, and volatile content.
2. Demonstrate competency in calculating mineral formulae, interpreting chemical compositions, and utilizing variation diagrams to classifmagmatic rocks based on whole-rock composition and chemical discriminants, thereby enhancing the understanding of rock petrology and geochemistry.

Learning outcomes

After the successful completion of the module, the learner will be able to –

1. Apply analytical techniques such as XRF, ICP-MS, EPMA, and SEM-EDS for sampling, analyses, and geo-standards, ensuring precision in determining mineral and glass compositions, major, minor, and trace elements, oxidation states, and volatile content.
2. Demonstrate competency in calculating mineral formulae, interpreting chemical compositions, and employing variation diagrams, enabling the classification of magmatic rocks based on whole-rock composition and chemical discriminants.

Subtopic	Title	15 L
1.1	Analytical principles and procedures: XRF, ICP-MS, EPMA and SEM-EDS, sampling, analyses, geo-standards, accuracy and precision, mineral and glass compositions, major, minor and trace elements and relative abundances, oxidation states and volatile, FeO, Fe2O3	9 L

	and Total Fe, Mg #, mole conversions, mineral formulae calculations, chemical compositions and variation diagrams.	
1.2	Classification of magmatic rocks based on whole-rock composition, Chemical discriminant of rock types.	6 L

References

- Ragland, P. C. (1989). Basic Analytical Petrology. United Kingdom: Oxford University Press.
- Ague, J. J., Philpotts, A. R. (2022). Principles of Igneous and Metamorphic Petrology. Singapore: Cambridge University Press.
- Winter, J. D. (2001). An Introduction to Igneous and Metamorphic Petrology. United Kingdom: Prentice Hall.
- Wilson, M. (1989). Igneous Petrogenesis. London Unwin Hyman

Module II	Application of isotope geochemistry in Igneous petrogenesis	15L

Learning objectives

The module is intended to –

1. Develop proficiency in stable and radiogenic isotopes, understanding their significance as petrogenetic indicators and their role in interpreting chronological data.
2. Acquire practical skills in using Isoplot software for interpreting and presenting isotopic data, enhancing proficiency in handling chronological information effectively.

Learning outcomes

After the successful completion of the module, the learner will be able to –

1. Proficiently understand stable and radiogenic isotopes, utilizing them as petrogenetic indicators, and interpreting chronological data, demonstrating expertise in isotope applications.
2. Gain hands-on experience with Isoplot, enabling effective interpretation and presentation of isotopic data, and reinforcing practical skills in handling chronological information.

Subtopic	Title	15 L
2.1	Stable and radiogenic isotopes, mass fractionation, radiogenic decay, isotopes as petrogenetic indicators, K-Ar system, isochron technique, Rb-Sr, U-Pb-Th and Sm-Nd systems, model ages.	10 L
2.2	Interpretation of chronological data, isotope reservoirs. Introduction to isoplot software.	5 L

References

- Best, M. G. (2013). Igneous and Metamorphic Petrology. Wiley Blackwell5.
- White, W. M. (2015). Isotope Geochemistry. United Kingdom: Wiley.6.
- Faure, G. and Mensing, T. M. (2009) Isotope principles and Applications.7.
- Rollinson, H. R. (2014). Using Geochemical Data: Evaluation, Presentation, Interpretation. United Kingdom: Taylor & Francis.

Question Paper Template

M. Sc. (Geology) SEMESTER I

Department Specific Elective - II

COURSE TITLE: Analytical Geochemistry

COURSE CODE 23PSIGEDSEAGC

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

Practical
23PSIGEDSEAGCP

DSE II	Analytical Geochemistry Practical

Learning Objectives

This Practical is intended to

1. Develop proficiency in conducting whole rock analysis of igneous rocks using XRF, ensuring accurate determination of major and trace element compositions.
2. Acquire skills in norm calculations and utilizing GEOSOFTWARE for interpreting and applying petrological data effectively in geological studies.

Learning Outcomes

After the successful completion of the Practical, the learner will be able to

1. Students will demonstrate competency in performing whole rock analysis using XRF, enabling precise characterization of major and trace element compositions in igneous rocks.
2. They will proficiently apply norm calculations and GEOSOFTWARE, facilitating interpretation and utilization of petrological data for geological investigations and research.

1. Whole rock analysis of igneous rocks using XRF
2. Norm calculations and application of GEOSOFTWARE.
3. MELT programme
4. Ar40-Ar39 age calculations using the ArArCALC software.
5. Model age calculations
6. Use of Isoplot software with special emphasis on U-Pb concordia, Sm-Nd and Lu-Hf technique
7. Mineral formulae calculations

MSc Geology Semester I

Discipline Specific Elective - III

COURSE TITLE: Volcanology

COURSE CODE 23PSIGEDSEVCG

[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to – 1. Possess a strong understanding of volcanic processes, covering historical background, magmas, melting, and global volcanism, including mid-ocean ridges, oceanic islands, continental volcanoes, and island arcs. 2. Analyze volcanic edifices, explosive eruptions, pyroclastic falls, surges, lahars, and magma-water interactions, acquiring comprehensive knowledge of associated hazards. 3. Explain the ideas of volcanic hazards and the various hazard management processes 4. Analyze and apply the concepts on other planets to study extraterrestrial volcanism

Module I	Volcanism and Deposits	15L

Learning objectives

The module is intended to –

1. Gain comprehensive knowledge of volcanic processes, including historical context, magma genesis, melting mechanisms, and the global distribution of volcanism across diverse tectonic settings.

2. Develop analytical skills to study volcanic edifices, explosive eruption dynamics, pyroclastic fall mechanisms, surge phenomena, lahars, and magma-water interactions, enhancing understanding of associated hazards and their mitigation strategies.

Learning outcomes

After the successful completion of the module, the learner will be able to –

1. Possess a strong understanding of volcanic processes, covering historical background, magmas, melting, and global volcanism, including mid-ocean ridges, oceanic islands, continental volcanoes, and island arcs.
2. Analyze volcanic edifices, explosive eruptions, pyroclastic falls, surges, lahars, and magma-water interactions, acquiring comprehensive knowledge of associated hazards.

Subtopic	Title	15 L
1.1	Introduction/ Historical Background, Magmas and Melting	5 L
1.2	Global Volcanism: Mid-ocean ridges, oceanic islands, Continental Volcanoes and Island Arcs, Volcanic Edifices and Deposits,	5 L
1.3	Explosive Eruptions, Pyroclastic Falls and Flow Deposits, Surges; Lahars, Magma & Water	5 L

References

- Schmincke, H. (2012). Volcanism. Germany: Springer Berlin Heidelberg.
- Wilson, L., Parfitt, L. (2009). Fundamentals of Physical Volcanology. Germany: Wiley.
- Wright, J. V., Giordano, G., Cas, R. (2023). Volcanology: Processes, Deposits, Geology and Resources. Switzerland: Springer International Publishing.

Module II	Hazards and Case Studies	[15L]

Learning objectives

The module is intended to –

1. Acquire proficiency in explaining volcanic hazards and various hazard management processes, enabling effective communication and implementation of mitigation strategies.
2. Develop the ability to analyze and apply volcanic concepts to extraterrestrial environments, facilitating the study of extraterrestrial volcanism and its implications for planetary geology.

Learning outcomes

After the successful completion of the module, the learner will be able to –

1. Explain the ideas of volcanic hazards and the various hazard management processes
2. Analyze and apply the concepts on other planets to study extraterrestrial volcanism

Subtopic	Title	15 L
2.1	Volcanic Hazards, Volcanic Hazard Assessment & Management/OPEN, Benefits of Volcanoes,	9 L
2.2	Case Histories: Iceland, Japan, Mid-ocean ridges, Mt. St. Helens, Hawaii, ,Extraterrestrial Volcanism	6 L

References

- Acocella, V. (2021). Volcano-Tectonic Processes. Germany: Springer International Publishing.

- Jerram, D. (2011). Introducing Volcanology: A Guide to Hot Rocks. United Kingdom: Dunedin Academic Press.
- de la Cruz-Reyna, S., Lockwood, J. P., Hazlett, R. W. (2022). Volcanoes: Global Perspectives. United Kingdom: Wiley.

Question Paper Template

M. Sc. (Geology) SEMESTER I

Department Specific Elective - III

COURSE TITLE: Volcanology

COURSE CODE 23PSIGEDSEVCG

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

Practical

23PSIGEDSEVCGP

DSE III	Type Study of Invertebrate and Vertebrate

Learning Objectives

This practical is intended to

1. Develop proficiency in identifying volcanic rocks through both hand specimen examination and microscopic analysis, focusing on key diagnostic features.
2. Acquire skills in recognizing and interpreting volcanic rock textures, including phenocrysts, groundmass characteristics, and vesicularity, enhancing understanding of volcanic processes and environments.

Learning Outcomes

After the successful completion of the practical, the learner will be able to

1. By the end of the practicals, students will demonstrate the ability to accurately identify a variety of volcanic rocks through hands-on examination and microscopic analysis, showcasing a comprehensive understanding of their mineralogical and textural characteristics.
2. Students will be able to effectively recognize and interpret volcanic rock textures, enabling them to infer eruption styles, magma properties, and depositional environments based on petrographic observations.

1. Hand-specimen Identification of Volcanic Rocks
2. Microscopic Identification of Volcanic Rocks
3. Identification of Volcanic rock textures.

MSc Geology Semester II

Major Core Course - I

COURSE TITLE: Sedimentary Geology

COURSE CODE - 23PS2GEMJISMG

[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to – 1. Demonstrate proficiency in the genesis and classification of major sedimentary rocks, including conglomerate, shale, sandstone, carbonate, and siliceous rocks. 2. Apply their knowledge to analyze diagenesis and recognize important sedimentary structures in sandstones, carbonates, and evaporites, enhancing their practical understanding of sedimentary geology. 3. Comprehensively understand diverse sedimentary environments, including marine, non-marine, and mixed environments, identifying and interpreting their characteristics. 4. Apply their knowledge of sedimentary basins, geosynclinal, and plate tectonics concepts to analyze plate movement and basin formation. They'll relate geological processes to the development of sedimentary basins within the context of plate tectonics.

Module I	Sedimentary Petrology	15L

Learning objectives

The module is intended to –

- Demonstrate proficiency in the genesis and classification of major sedimentary rocks.

- Analyze diagenesis and recognize important sedimentary structures.

Learning outcomes

After the successful completion of the module, the learner will be able to –

5. Demonstrate proficiency in the genesis and classification of major sedimentary rocks, including conglomerate, shale, sandstone, carbonate, and siliceous rocks.
6. Apply their knowledge to analyze diagenesis and recognize important sedimentary structures in sandstones, carbonates, and evaporites, enhancing their practical understanding of sedimentary geology.

Subtopic	Title	15L
1.1	Genesis and classification of major sedimentary rocks: conglomerate, shale, sandstone carbonate and siliceous rocks;	8 L
1.2	Diagenesis of sandstones, carbonates, and evaporites. Important Sedimentary structures.	7 L

References

- Prothero, D. R., & Schwab, F. (2004). Sedimentary geology. Macmillan.
- Tucker, M. E. (2006) Sedimentary Petrology, Blackwell Publishing.
- Collinson, J. D. &Thompson, D. B. (1988) Sedimentary structures, Unwin-Hyman, London.

Module II	Sedimentary Environments and Facies	15L

Learning objectives

The module is intended to

- Understand diverse sedimentary environments.

- Analyze sedimentary basins within the context of plate tectonics.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Comprehensively understand diverse sedimentary environments, including marine, non-marine, and mixed environments, identifying and interpreting their characteristics.
- Apply their knowledge of sedimentary basins, geosynclinal, and plate tectonics concepts to analyze plate movement and basin formation. They'll relate geological processes to the development of sedimentary basins within the context of plate tectonics.

Subtopic	Title	15L
2.1	Facies Modelling; Marine Environments: Continental Shelf, Continental Slope, Continental Rise; Non-Marine Environments: Glacial, Aeolian, Lacustrine, Fluvial Mixed Environments: Barrier Island, Tidal Flats; Deltaic Environment	8 L
2.2	Sedimentary Basins, Geosynclinal Concept, Plate Tectonics Concept, Plate movement and Basin Formation.	7 L

References

- Nichols,G. (2009) Sedimentology and Stratigraphy Second Edition. Wiley Blackwell
- Lewis, D.W. and McConchie, D., (1984) Practical sedimentology Wiley Blackwell

Question paper Template

M. Sc. (Geology) SEMESTER II

Major Core Course - I

COURSE TITLE: Sedimentary Geology

COURSE CODE 23PSIGEMJISMG

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

MSc Geology Semester II

Major Core Course - II

COURSE TITLE: Metamorphic Petrology

COURSE CODE - 23PS2GEMJ2MMP

[CREDITS - 02]

Course learning outcomes

After the successful completion of the Course, the learner will be able to –

1. Comprehensively understand metamorphism, covering its definition, significance, and factors controlling studies. They'll analyze metamorphic textures and interpret transformations in the context of tectonics.
2. Demonstrate proficiency in analyzing rocks as a chemical system, understanding variables and applying the Gibbs phase rule. They'll interpret phase diagrams, including pseudo component diagrams (ACF, AFM, etc.), and comprehend reactions like continuous and discontinuous processes, alongside the Clayperon equation.
3. Gain an advanced understanding of metamorphic zones, progressive metamorphism in diverse bulk compositions, and related concepts like metamorphic facies, Schreinemakers rules, mineral formula calculations, geothermobarometry, and the study of complex phenomena like migmatites.
4. Demonstrate proficiency in analysing metamorphic field data, and interpreting field gradients, and P-T-t paths. They will use geothermobarometric techniques to decipher the conditions of metamorphic rock formation, advancing their skills in reconstructing metamorphic histories.
5.

Module I	Types and factors of metamorphism	15L

Learning objectives

The module is intended to –

- Comprehensive understanding of metamorphism.
- Proficiency in analyzing rocks as a chemical system.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Comprehensively understand metamorphism, covering its definition, significance, and factors controlling studies. They'll analyze metamorphic textures and interpret transformations in the context of tectonics.
- Demonstrate proficiency in analyzing rocks as a chemical system, understanding variables and applying the Gibbs phase rule. They'll interpret phase diagrams, including pseudo component diagrams (ACF, AFM, etc.), and comprehend reactions like continuous and discontinuous processes, alongside the Clayperon equation.

Subtopic	Title	15 L
1.1	Definition and limits of metamorphism, significance of metamorphic studies, factors controlling metamorphism, metamorphic texture, tectonic context of metamorphic transformation.	7 L
1.2	Rocks as a chemical system, intensive and extensive variable, Gibbs phase rule, Phase diagrams including pseudo component diagram (ACF, AFM etc), continuous and discontinuous reaction, Clayperon equation	8 L

References

- Bucher, K. and Grapes, R (2010). Petrogenesis of Metamorphic Rocks, Springer.
- Best, M.G. (2003). Igneous and Metamorphic Petrology, Blackwell Science.
- Vernon, R. H. and Clarke, G.L. (2008). Principles of Metamorphic Petrology, Cambridge University Press.

Module II	Metamorphic Zones, isograds and facies	15L

Learning objectives

The module is intended to

- Advanced understanding of metamorphic zones and related concepts.
- Proficiency in analyzing metamorphic field data and interpreting metamorphic histories.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Gain an advanced understanding of metamorphic zones, progressive metamorphism in diverse bulk compositions, and related concepts like metamorphic facies, Schreinemakers rules, mineral formula calculations, geothermobarometry, and the study of complex phenomena like migmatites.
- Demonstrate proficiency in analysing metamorphic field data, and interpreting field gradients, and P-T-t paths. They will use geothermobarometric techniques to decipher the conditions of metamorphic rock formation, advancing their skills in reconstructing metamorphic histories.

Subtopic	Title	15L

2.1	Metamorphic zones and isograds, progressive metamorphism of any two bulk chemical compositions (pelitic, quartz-feldsapthic, mafic and calcareous),	8 L
2.2	Metamorphic facies, Schreinemakers rules, Mineral formula calculation, geothermobarometry, migmatites, Metamorphic field gradient and P-T-t paths	7 L

References

- Winter, J.D. (2001). An Introduction to Igneous and Metamorphic Petrology, Prentice Hall.
- Yardley, B.W.D (1997). An Introduction to Metamorphic Petrology, Longman Earth Science Series.
- Spear, F.S. (1995). Metamorphic Phase Equilibria and Pressure-Temperature-Time paths, Mineralogical Society of America Monograph.

Question paper Template

M. Sc. (Geology) SEMESTER II

Major Core Course- II

COURSE TITLE: Metamorphic Petrology

COURSE CODE 23PSIGEMJI2MMP

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

MSc Geology Semester II

Major Core Course - III

COURSE TITLE: Mineral Exploration and Mineral Economics

COURSE CODE - 23PS2GEMJ3MEE

[CREDITS - 02]

Course learning outcomes

After the successful completion of the Course, the learner will be able to –

1. Master mineral exploration principles, prospecting methods, exploration stages, sampling techniques, subsurface exploration, and reserve estimation, including cut-off grade concepts and conventional methods.
2. Understand principles of geochemical exploration, recognize primary and secondary element dispersions, determine background values and anomalies, identify pathfinder and target elements. They'll also be skilled in geochemical exploration methods, sampling procedures, and survey interpretation.
3. Grasp mineral resource classification (UNFC, JORC), IBM Guidelines, mineral markets, import-export policies, and international trade. They will analyze mineral demand, royalties, taxes, and understand India's mineral production status, along with international and national mineral policies, enhancing their knowledge of mines and mineral policies.
4. Master the Mines and Minerals (Development and Regulation) Act, understand marine resources and the International Land Sea Convention, evaluate mineral deposits economically, and learn methods for mineral conservation and substitution, enhancing their knowledge of legal frameworks, international conventions, and sustainable mining practices.

Module I	Mineral Exploration	15L

Learning objectives

The module is intended to –

- Master mineral exploration principles and techniques
- Understand principles of geochemical exploration

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Master mineral exploration principles, prospecting methods, exploration stages, sampling techniques, subsurface exploration, and reserve estimation, including cut-off grade concepts and conventional methods.
- Understand principles of geochemical exploration, recognize primary and secondary element dispersions, determine background values and anomalies, identify pathfinder and target elements. They'll also be skilled in geochemical exploration methods, sampling procedures, and survey interpretation.

Subtopic	Title	15L
1.1	Principles and concepts of mineral exploration, methods of Prospecting and Exploration. Different Stages of mineral Exploration. Sampling and Subsurface exploration. Reserve Estimation: Cut-off grade concepts and applications, Reserve Estimation–principles, practices and different conventional methods	8 L
1.2	Principles of Geochemical Exploration, Primary and secondary dispersions of elements; Determination of background, and geochemical anomalies; Pathfinder and target elements for	7 L

	geochemical exploration. Methods of geochemical explorations, Procedures for geochemical sampling; Interpretation of geochemical surveys.	

References:

- Reedman, J. (2011). Techniques in Mineral Exploration. Netherlands: Springer Netherlands.
- Peters, W. C. (1978). Exploration and Mining Geology. United Kingdom: Wiley.
- Haldar, S. K. (2018). Mineral Exploration: Principles and Applications. Netherlands: Elsevier Science.
- Moon, C., G. Whateley, M. K., & Evans, A. M. (Eds.). (2009). Introduction to Mineral Exploration. Wiley-Blackwell.
- Gandhi, S. M., Sarkar, B. C. (2016). Essentials of Mineral Exploration and Evaluation. Netherlands: Elsevier Science.

Module II	Mineral Economics	15L

Learning objectives

The module is intended to

- Grasp mineral resource classification and market dynamics.
- Master legal frameworks and sustainable mining practices.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Grasp mineral resource classification (UNFC, JORC), IBM Guidelines, mineral markets, import-export policies, and international trade. They will analyze mineral demand, royalties, taxes, and understand India's mineral production status, along with international and national mineral policies, enhancing their knowledge of mines and mineral policies.

- Master the Mines and Minerals (Development and Regulation) Act, understand marine resources and the International Land Sea Convention, evaluate mineral deposits economically, and learn methods for mineral conservation and substitution, enhancing their knowledge of legal frameworks, international conventions, and sustainable mining practices.

Subtopic	Title	15L
2.1	Classification of mineral resources with special reference to UNFC and JORC schemes. IBM Guidelines, Mineral markets, Import-Export policies and International Trade. Demand analysis of minerals, Royalty and Taxes. India's status in mineral production. International and national mineral policies. Mines and Mineral policies. Mines and Minerals (Development and Regulation) act. Marine and mineral resources and International Land Sea Convention	9 L
2.2	Economic evaluation of mineral deposit. Methods of mineral conservation and substitution	6 L

References

- Sinha, R. K. (2019). Mineral Economics. India: CBS Publishers & Distributors.
- Chatterjee, K. K. (2010). Lectures and Thoughts on Mineral Economics. United States: Nova Science Publishers.
- Jawadand, S., Randive, K. (2020). Mineral Economics: An Indian Perspective. United States: Nova Science Publishers, Incorporated.
- Sarkar, S. C., Deb, M. (2017). Minerals and Allied Natural Resources and Their Sustainable Development: Principles, Perspectives with Emphasis on the Indian Scenario. Singapore: Springer Nature Singapore.

Question Paper Template

M. Sc. (Geology) SEMESTER II

Major Core Course- III

COURSE TITLE: Mineral Exploration and Mineral Economics

COURSE CODE 23PSIGEMJ3MEE

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

MSc Geology Semester II

Major Core Course - IV

COURSE TITLE: Paleontology

COURSE CODE - 23PS2GEMJ4PAL

[CREDITS - 02]

Course learning outcomes		

After the successful completion of the Course, the learner will be able to –

1. Acquire in-depth knowledge of important invertebrate groups (Bivalvia, cephalopods, Brachiopoda, Graptolites, Trilobites) and their biostratigraphic significance.
2. Develop expertise in the significance of ammonites in Mesozoic biostratigraphy, exploring their palaeobiogeographic implications, and analyze functional adaptations in trilobites and ammonoids.
3. Possess a fundamental understanding of palaeobotany, encompassing the definition, conditions, and diverse modes of plant fossil preservation, as well as an exploration of the evolving fossil record of plants over time.
4. Demonstrate analytical proficiency in examining the record of plant fossils in India, with a specific focus on the Gondwana Flora its broader geological significance.

Module I	Invertebrate Paleontology	15L

Learning objectives

The module is intended to –

- Acquire in-depth knowledge of important invertebrate groups and their biostratigraphic significance.
- Develop expertise in the significance of ammonites in Mesozoic biostratigraphy

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Acquire in-depth knowledge of important invertebrate groups (Bivalvia, cephalopods, Brachiopoda, Graptolites, Trilobites) and their biostratigraphic significance.
- Develop expertise in the significance of ammonites in Mesozoic biostratigraphy, exploring their palaeobiogeographic implications, and analyze functional adaptations in trilobites and ammonoids.

Subtopic	Title	15L
1.1	Study of important invertebrate groups (Bivalvia, cephalopods, Brachiopoda, Graptolites, Trilobites) and their biostratigraphic significance.	7 L
1.2	Significance of ammonites in Mesozoic biostratigraphy and their palaeobiogeographic implications Functional adaptation in trilobites and ammonoids.	8 L

References

- Raup, D. M., Stanley, S.M., Freeman, W. H. (1971). Principles of Paleontology
- Clarkson, E. N.K.(2012) Invertebrate Paleontology and evolution 4th Edition by Blackwell Publishing.
- Benton, M. (2014). Vertebrate Palaeontology, fourth edition

Module II	Paleobotany	15L

Learning objectives

The module is intended to

- Possess a fundamental understanding of palaeobotany.
- Demonstrate analytical proficiency in examining the record of plant fossils in India.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Possess a fundamental understanding of palaeobotany, encompassing the definition, conditions, and diverse modes of plant fossil preservation, as well as an exploration of the evolving fossil record of plants over time.
- Demonstrate analytical proficiency in examining the record of plant fossils in India, with a specific focus on the Gondwana Flora its broader geological significance.

Subtopic	Title	15 L
2.1	Introduction to Palaeobotany; Definition, conditions and different modes of presevation of plant fossils, fossil record of plants through time;	8 L
2.2	Record of plant fossils in India with reference to Gondwana Flora and Deccan Inter-trappean flora	7 L

References

- Shukla, A. C., & Misra, S.P. (1982). Essentials of Palaeobotany.

- Stewart, W.N. & Rothwell, G.W. (2018). Palaeobotany and the Evolution of Plants
- Armstrong, H.A., & Brasier, M.D. (2005) Microfossils. Blackwell Publishing
- Jones, R.W. (2011). Applications of Palaeontology - Techniques and Case Studies
- Briggs, D.E.G. & Crowther, P.R. (2003). Palaeobiology II.
- Foote, M. & Miller, A. I. (2006). Principles of Paleontology, third edition

Question paper Template

M. Sc. (Geology) SEMESTER II

Major Core Course- IV

COURSE TITLE: Paleontology

COURSE CODE 23PS2GEMJ4PAL

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

Practical

23PS2GEMJP1

Core course I	Sedimentary Geology

Learning Objectives

This Practical is intended to

- Develop proficiency in sedimentary rock identification and characterization
- Gain expertise in sedimentary rock analysis through thin sections

Learning Outcomes

After the successful completion of the Practical, the learner will be able to

- Identify sedimentary rocks by hand-specimen examination, describing their structures, and demonstrate proficiency in analyzing particle size distribution data to understand sedimentary material properties.
- Gain skills in analyzing sedimentary rocks in thin section, covering both clastic and non-clastic varieties, and understand diagenetic processes' effects on rock textures and mineralogy, improving interpretation of sedimentary environments and histories.

1. Study of important sedimentary rocks in hand-specimens
2. Particle size distribution and statistical analysis
3. Palaeocurrent analysis
4. Petrography of selected clastic and non-clastic rocks through thin sections with emphasis on diagenetic features.
5. Study of important sedimentary structures

Core course II	Metamorphic Petrology

Learning Objectives

This Practical is intended to make the students

- Proficient in identifying metamorphic rocks and textures.
- Develop an understanding of metamorphic phase diagrams and classification methods.

Learning Outcomes

After the successful completion of the Practical, the learner will be able to

- Proficiently identify metamorphic rocks of diverse compositions and grades under a microscope, interpreting special metamorphic textures to analyze metamorphic histories and conditions in detail.
- Master the use of Schrienemakers Method and ternary diagrams (ACF, AKF, A(K)FM) to interpret metamorphic phase assemblages, facilitating the classification of metamorphic rocks and deeper understanding of their formation processes in petrology.

1. Identification of metamorphic rocks and textures under microscope in different rock compositions of different metamorphic grade.
2. Special metamorphic textures: Foliation (I phyllite schist, gneiss), mineral layering, Pressure Shadow, Pre, Syn, Post Kinematic porphyroblast, Granoblastic texture, Crenulation Cleavage, Sympletitic texture, Corona texture .
3. Schrienemakers Method, ternary Diagram-ACF, AKF, A(K)FM.

Practical

23PS2GEMJP2

Core course III	Mineral Exploration and Mineral Economics

Learning Objectives:

The practicals are intended to help the learner

- Gain proficiency in reserve estimation techniques.
- Acquire understanding of cut-off grade decisions and anomaly mapping.

Learning Outcomes

After successful completion of the practical the learner will be able to

- proficiently apply reserve estimation techniques like Thiessen polygons and cross sections, accurately assessing mineral reserves, and interpret mineral reserve isopach maps to glean valuable insights into deposit distribution and resource potential.
- develop the capability to make informed cut-off grade decisions based on current market prices, ensuring optimal resource utilization, and gain expertise in geochemical anomaly mapping to identify and prioritize high mineral potential areas for further exploration and development.

1. Reserve Estimation using Thiessen polygon
2. Reserve Estimation using Cross Section for Bedded Deposit
3. Reserve Estimation using Longitudinal - Vertical Section for Inclined Deposits
4. Cut-off Grade Decision's Based on Current Market Prices
5. Geochemical Anomaly Mapping
6. Making Mineral Reserve isopach maps

Core course IV	Paleontology

Learning Objectives

The practical's are intended to

- Gain proficiency in fossil study and analysis.
- Understand the application of fossil analysis techniques.

Learning Outcomes

After successful completion of the practical the learner will be able to

- Proficiently analyze fossils, uncovering preservation modes, understanding fossilization processes, and identifying morphological characters, enriching their grasp of paleontological principles and methods.
- Apply Gondwana plant fossil knowledge to interpret paleoenvironments, improve problem-solving in fossil data analysis, range chart creation, and map significant fossils in India, advancing geological and paleontological research.

1. Study of fossils showing various modes of preservation.,
2. Study of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate fossils. - Bivalves, Cephalopods, Trilobites, Graptolites, Brachiopods,
3. Study of Gondwana plant fossils
4. Problems on Fossil Group and fossil assemblage, range chart problems
5. location of important fossils and formations on the map of India

MSc Geology Semester II

Discipline Specific Elective – I

COURSE TITLE: Applications of Paleontology

COURSE CODE: 23PS2GEDSEAPL

[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to - 1. Proficiently apply fossils in stratigraphy, mastering biozones, index fossils, and correlation techniques. They will also understand the role of fossils in sequence stratigraphy and their significance in palaeoenvironmental analysis. 2. Gain a comprehensive understanding of fossils in paleobiogeography, including biogeographic provinces, dispersals, and barriers. They'll explore fossils as windows to ecosystem evolution and the utility of ichnofossils in interpreting sedimentary environments. 3. Demonstrate proficiency in micropaleontological techniques, including the collection, preparation, and preservation of microfossils from Phanerozoic rocks in India. 4. Gain an applied understanding of micropaleontology, with a focus on ostracods, foraminifera, radiolaria, and conodonts. They will also comprehend the environmental significance of pollen and spores, contributing to a broader understanding of microfossil diversity and ecological contexts.

Module I	Applications of Paleontology	15L

Learning objectives

The module is intended to -

- Proficiency in utilizing fossils for stratigraphy
- Comprehensive understanding of fossils in paleobiogeography

Subtopic	Title	15 L
1.1	Application of fossils in Stratigraphy; Biozones, index fossils, correlation; Role of fossils in sequence stratigraphy; Fossils and palaeoenvironmental analysis; Fossils and paleobiogeography, biogeographic provinces, dispersals and barriers	8 L
1.2	Paleoecology – fossils as a window to the evolution of ecosystems. Introduction to Ichnology; utility of ichnofossils in interpreting sedimentary environments.	7 L

References

- Raup, D. M., Stanley, S.M., Freeman, W. H. (1971). Principles of Paleontology
- Clarkson, E. N.K.(2012)Invertebrate Paleontology and evolution 4th Edition by Blackwell Publishing.
- Benton, M. (2014). Vertebrate Palaeontology, fourth edition
- Shukla, A. C., & Misra, S.P. (1982).Essentials of Palaeobotany.
- Stewart, W.N. & Rothwell, G.W. (2018). Palaeobotany and the Evolution of Plants

Module II	Applications of micropaleontology	15L

Learning objectives

The module is intended to -

- Develop proficiency in micropaleontological techniques.
- Applied understanding of micropaleontology.

Learning outcomes

After the successful completion of the module, the learner will be able to -

- Demonstrate proficiency in micropaleontological techniques, including the collection, preparation, and preservation of microfossils from Phanerozoic rocks in India.
- Gain an applied understanding of micropaleontology, with a focus on ostracods, foraminifera, radiolaria, and conodonts. They will also comprehend the environmental significance of pollen and spores, contributing to a broader understanding of microfossil diversity and ecological contexts.

Subtopic	Title	15L
2.1	Introduction to micropaleontology Record of microfossils from Phanerozoic rocks of India Collection, preparation and preservation of microfossils.	7 L
2.2	Introduction to micropaleontology with reference to ostracods, foraminifera, Radiolaria, and conodonts, environmental significance of Pollens and Spores	8 L

References

- Armstrong, H.A., & Brasier, M.D. (2005) Microfossils. Blackwell Publishing
- Jones, R.W. (2011). Applications of Palaeontology - Techniques and Case Studies
- Briggs, D.E.G. & Crowther, P.R. (2003). Palaeobiology II.
- Foote, M. & Miller, A. I. (2006). Principles of Paleontology, third edition.

Practical

23PS2GEDSEAPLP

DSE I	Applications of Paleontology

Learning Objectives

This Practical is intended to

- Develop skills in solving problems related to in biozone problems and stratigraphic correlation.
- Acquire knowledge and techniques for utilizing fossils in paleoenvironmental analysis, interpreting past environmental conditions.

Learning Outcomes

After the successful completion of the Practical, the learner will be able to

- Demonstrate proficiency in solving biozone problems and correlating strata using index fossils, facilitating accurate stratigraphic interpretations and geological reconstructions.
- Apply fossil knowledge to analyze past environmental conditions, contributing to paleoenvironmental reconstructions, and develop expertise in identifying plant fossils, enriching understanding of Earth's past ecosystems and geological processes.

1. Problems on biozone
2. Problem on corelation of strata and index fossils
3. Fossils and paleoenvironmental analysis
4. Identification of plant fossils and role in paleogeography
5. Micropaleontology

MSc Geology Semester II

Discipline Specific Elective - II

COURSE TITLE: Coal and Petroleum Geology

COURSE CODE: 23PS2GEDSECPG

[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to – 1. Attain in-depth knowledge of coal geology, covering the origin, occurrence, prospecting methods, physical and chemical constituents, utilization, classification, and structural features of coal seams. 2. Demonstrate applied expertise in coal sampling in both mines and laboratories and a comprehensive understanding of coal mining methods. They will analyze Indian coals, considering geology, grade, economic reserves, and future prospects, enhancing their ability to assess and manage coal resources effectively. 3. Comprehensively understand the physical and chemical properties of petroleum, migration, accumulation, geophysical prospecting, and the concepts of traps and reservoirs. 4. Gain applied knowledge by studying potential sedimentary basins and oil fields in India, understanding India's current position and future prospects in petroleum and natural gas within the global energy context.		
Module I	Coal Geology	15L
Learning objectives		

The module is intended to – 1. Attain comprehensive knowledge of coal geology, covering origin, occurrence, prospecting, constituents, utilization, classification, and structural features of coal seams. 2. Develop expertise in coal sampling and mining methods, analyzing Indian coals for resource assessment and management.
Learning outcomes After the successful completion of the module, the learner will be able to – 1. Attain in-depth knowledge of coal geology, covering the origin, occurrence, prospecting methods, physical and chemical constituents, utilization, classification, and structural features of coal seams. 2. Demonstrate applied expertise in coal sampling in both mines and laboratories and a comprehensive understanding of coal mining methods. They will analyze Indian coals, considering geology, grade, economic reserves, and future prospects, enhancing their ability to assess and manage coal resources effectively.

Subtopic	Title	15 L
1.1	Origin, mode of Occurrence of Coal, Prospecting for Coal Physical and Chemical constituents of Coal, Utilization of Coal Classification and Structural Features of Coal Seams.	7 L
1.2	Sampling of coal in Mines and in the Laboratory; Methods of Coal mining Study of Indian Coals with reference to Geology, grade of coal, economic reserves and future prospects.	8 L

References

- Diessel, C. F. (2012). Coal-Bearing Depositional Systems. Germany: Springer Berlin Heidelberg.
- Thomas, L. (2020). Coal Geology. United Kingdom: Wiley.
- Rogers, R. E. (1994). Coalbed methane: principles and practice. United States: PTR Prentice Hall.
- Thomas, L. (1992). Handbook of practical coal geology. United Kingdom: Wiley.

Module II	Petroleum Geology	15L

Learning objectives

The module is intended to

1. Understand petroleum properties, migration, accumulation, geophysical prospecting, traps, and reservoirs.
2. Gain practical insight into India's sedimentary basins, oil fields, and energy prospects in the global context.

Learning outcomes

After the successful completion of the module, the learner will be able to –

1. Comprehensively understand the physical and chemical properties of petroleum, migration, accumulation, geophysical prospecting, and the concepts of traps and reservoirs.
2. Gain applied knowledge by studying potential sedimentary basins and oil fields in India, understanding India's current position and future prospects in petroleum and natural gas within the global energy context.

Subtopic	Title	15L

2.1	Physical and Chemical properties of Petroleum, Petroleum Traps and Reservoirs Migration accumulation and Geophysical Prospecting of Petroleum.	7 L
2.2	Study of potential sedimentary basins and oil fields of India, India's position as regards to Petroleum and Natural Gas and future prospects	8 L

References

- Sonnenberg, S. A., Selley, R. C. (2022). Elements of Petroleum Geology. Netherlands: Elsevier Science.
- Tissot, B., Welte, D. (2013). Petroleum Formation and Occurrence. Germany: Springer Berlin Heidelberg.
- Chapman, R. (2000). Petroleum Geology. Netherlands: Elsevier Science.

Practical

23PS2GEDSECPGP

DSE II	Coal and Petroleum Geology Practical

Learning Objectives

This Practical is intended to

1. Develop proficiency in assessing both the physical properties of coal and the source rock potential of petroleum formations through practical laboratory techniques.
2. Acquire skills in various analytical methods, including proximate analysis of coal and Rock-Eval pyrolysis for source rock evaluation, as well as well log and seismic data analysis for petroleum exploration.

Learning Outcomes

After the successful completion of the Practical, the learner will be able to

1. By the end of the practical sessions, students will accurately evaluate the physical properties of coal and assess the source rock potential of petroleum formations, enhancing their understanding of energy resources and their geological characteristics.
2. Students will demonstrate competence in utilizing analytical techniques such as proximate analysis and Rock-Eval pyrolysis for coal and petroleum source rock assessment, as well as interpreting well log and seismic data for reservoir characterization, enabling effective decision-making in energy exploration and resource estimation.

1. Physical Properties of Coal
2. Classification of Coal Lithotypes in Hand specimen
3. Seam Formation Curve

4. Coal Reserve Estimation
5. Structural Problems in Coal Basins
6. Proximate Analysis of Coal
7. Source Rock Potential using Rock eval Pyrolysis
8. Well Log Analysis
9. Seismic Data Analysis
10. Drawing oil/water contact from borehole data.
11. Preparation of structure contour and isopach maps of reservoir facies
12. Hydrocarbon Reserve Estimation

MSc Geology Semester II

Discipline Specific Elective - III

COURSE TITLE: Stratigraphy of India

COURSE CODE: 23PS2GEDSESTI

[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to – 1. Gain a thorough understanding of the geological evolution of Archean cratons, including Dharwar, Bastar, Singhbhum, Aravalli, and Bundelkhand, analyzing the complex processes shaping these regions. 2. Demonstrate proficiency in analyzing regional geological features within Archean cratons, focusing on Dharwar, Bastar, Singhbhum, Aravalli, and Bundelkhand, gaining insights into the diverse events and processes contributing to their evolution. 3. Demonstrate proficiency in understanding the spatio-temporal distribution of Proterozoic basins in India, analyzing the geological and temporal characteristics shaping these basins. 4. Attain a comprehensive understanding of the geological features and evolution of diverse Indian basins including Kashmir, Spiti, Gondwana, Kutch, Narmada, and Trichinopoly, gaining insights into the unique geological processes that have shaped each region.		
Module I	Precambrian Craton	15L
Learning objectives The module is intended to –		

1. Understand the geological evolution of Archean cratons, analyzing complex processes shaping regions like Dharwar, Bastar, Singhbhum, Aravalli, and Bundelkhand.
2. Analyze regional geological features within Archean cratons, gaining insights into diverse events and processes contributing to their evolution.

Learning outcomes

After the successful completion of the module, the learner will be able to

1. Gain a thorough understanding of the geological evolution of Archean cratons, including Dharwar, Bastar, Singhbhum, Aravalli, and Bundelkhand, analyzing the complex processes shaping these regions.
2. Demonstrate proficiency in analyzing regional geological features within Archean cratons, focusing on Dharwar, Bastar, Singhbhum, Aravalli, and Bundelkhand, gaining insights into the diverse events and processes contributing to their evolution.

Subtopic	Title	15 L
1.1	Geological evolution of Archean craton Dharwar, Bastar, Singhbhum,	9 L
1.2	Aravalli and Bundelkhand	6 L

References

- Valdiya, K. S. (2010). The making of India, Macmillan India Pvt. Ltd.
- Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.

Module II	Basins of India	15L

Learning objectives

The module is intended to

1. Demonstrate proficiency in understanding the spatio-temporal distribution of Proterozoic basins in India, analyzing their geological characteristics.
2. Gain a comprehensive understanding of diverse Indian basins, including Kashmir, Spiti, Gondwana, Kutch, Narmada, and Trichinopoly, and the unique geological processes shaping each region.

Learning outcomes

After the successful completion of the module, the learner will be able to –

1. Demonstrate proficiency in understanding the spatio-temporal distribution of Proterozoic basins in India, analyzing the geological and temporal characteristics shaping these basins.
2. Attain a comprehensive understanding of the geological features and evolution of diverse Indian basins including Kashmir, Spiti, Gondwana, Kutch, Narmada, and Trichinopoly, gaining insights into the unique geological processes that have shaped each region.

Subtopic	Title	15L
2.1	Spatio-temporal distribution of proterozoic basins in India.	7 L
2.2	Geology of Kashmir, Spiti, Gondwana, Kutch, Narmada and Trichinopoly basins.	8 L

References

- Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers, Delhil.
- Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley

- Ramakrishnan, M. & Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological society of India, Bangalore.
- https://www.dghindia.gov.in/index.php/page?pageId=67&name=Indian%20Geology

Practical

23PS2GEDSESTIP

DSE III	Stratigraphy Practical

Learning Objectives

This Practical is intended to

1. Interpret geological maps of India and identify major stratigraphic units, refining skills in mapping and stratigraphic analysis.
2. Study rocks in hand specimens from known Indian stratigraphic horizons to recognize geological features and depositional environments.

Learning Outcomes

After the successful completion of the Practical, the learner will be able to

1. Accurately interpret geological maps, identifying major stratigraphic units and understanding their distribution.
2. Demonstrate proficiency in studying rocks from known stratigraphic horizons, recognizing geological features and lithologies effectively.

1. Study of geological map of India and identification of major stratigraphic units
2. Study of rocks in hand specimens from known Indian stratigraphic horizons
3. Study of common fossil characteristics of a particular stratigraphic horizon.
4. Interpretation of various stratigraphic logs and their correlation
5. International Stratigraphic Nomenclature code

8. Teaching learning process

The pedagogic methods adopted, involve direct lectures, tutorial discussions, as well as technology- supported presentations. We believe that education is interactive and all sessions between students and teachers are based upon reciprocity and respect.

1. The lectures (of 1 hr duration) delivered to one whole class at a time systematically deal with the themes of the syllabus. This constitutes the core of the teaching- learning process. The students are provided with bibliographic references and encouraged to go through at least some readings so that they could be more interactive and ask more relevant questions in the class. This also helps obtain knowledge beyond the boundaries of the syllabi.
2. Wherever needed, teachers use audio-video based technology devices (e. g. power point, YouTube videos) to make their presentations more effective. Some courses require that students see a documentary or feature film and course themes are structured so that discussions of these will further nuance the critical engagement of students with ideas introduced in their textual materials.
3. Remedial coaching, bridge courses are adopted to enhance the scope of learning for the learners. Remedial sessions are conducted to offer assistance on certain advanced topics. Bridge courses facilitate the development of a concrete basis for the topics to be learnt in the coming academic year.

9. Assessment Methods

Evaluation Pattern: Theory

- Assessments are divided into two parts: Continuous Internal Evaluation (CIE) and End Semester Examination (ESE).
- The CIE is taken at regular intervals in the form of Seminar presentations, MCQ based tests, Paper Summary writing etc.
- The End Semester Examination shall be conducted by the College at the end of each semester. (30M) Duration: 1.5 hours
  End Semester Examination Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	24 M	15 M
2	II	24 M	15 M

Each question will have six sub questions a, b, c, d, e, f and out of which any three should be answered.

Evaluation pattern: Practical

- Continuous Assessment for 25 Marks [P1+P2] throughout the entire semester.
- 50 Marks End Semester Evaluation as per the following rubrics [25 marks P1+25 marks P2}

Major Core Course	CIE	Experimental Report	Viva	Total
MJ 1	15 M	5 M	5 M	25 M
MJ 2	15 M	5 M	5 M	25 M

10. Programme and Course Code Format

The course is coded according to following criteria:

1. First two numbers in each course code indicates year of implementation of syllabus (23- year of implementation is 2023-24)
2. Third letter 'P' designates postgraduate
3. Fourth letter 'S' designate Science discipline and the digit followed is for semester number (S1 – 1st Semester)
4. Letter 'GE' is for Geology discipline (GE-Geology). This forms the programme code 23PS1GE. For the further course codes programme code is amended as follows
5. To represent Major Core Course (MJ) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
6. To represent Minor Stream Course (MN) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
7. For Discipline Specific Elective Course Code, (DSE) alphabets followed by a digit (1/2/3) followed by three letters specifying the course title are used.
8. 'P' followed by digit indicates practical course number. (Practical course number will be added for semesters only where there is more than one course.